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ABSTRACT

This study was undertaken in order to gather information concerning conversion to the metric system by other countries which might be useful in planning for conversion by the United States. Representatives of organizations in five countries (United Kingdom, Australia, South Africa, New Zealand, and Canada) which had recently converted to the metric system were surveyed. The survey instrument was designed to cover 15 key areas related to influences for and resistance to conversion, scheduling, teaching strategies, development of materials and programs, and suggestions for the United States. Concurrently with the survey the investigators developed an overseas data collection network and a complex information storage system, and conducted an intensive literature review. Findings are related to: (1) the identification of groups exerting influence for metrication; (2) strategies, materials and special problems of metric instruction; (3) teacher training; and (4) changes respondents would make in their country's approaches. Nine implications and recommendations are posed by the investigators. This report includes discussions of the programs in each of the five countries and an extensive bibliography. (SD)

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FINAL REPORT

GOING METRIC: AN ANALYSIS OF EXPERIENCES IN FIVE NATIONS AND THEIR IMPLICATIONS FOR U. S. EDUCATIONAL PLANNING

NATIONAL INSTITUTE OF EDUCATION PROJECT NO. 3-2173

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1974

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American Institutes for Research
in the Behavioral Sciences

Palo Alto, California

1974

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Needless to say, any errors there may be in this report are the responsibility of the authors.

Albert B. Chalupsky
Project Director

SUMMARY

The U. S. is now approaching total commitment to "going metric." This pervasive change will present substantial education and training problems. We are in a unique position to make effective and timely use of the metric conversion experiences now occurring in five other countries: the United Kingdom, Australia, South Africa, New Zealand, and Canada.

The major objectives of this exploratory study were: to review metric conversion in these selected foreign countries to identify attendant educational problems; to examine the educational changes made to facilitate conversion; to relate such conversion steps to problems and progress; and to make recommendations on how the experiences of countries undergoing conversion can best be utilized in the U. S.

A four-pronged approach was employed to explore metric conversion in education in the five countries. This included: the creation of an overseas data collection network; the design of an information storage system; an intensive literature search and analysis, and a direct survey of key educational organizations. The approach to metrication in the five target countries is reviewed. The recent metrication history of each country is described along with the metric organization developed, the schedule, and major strategies employed.

Major findings include: the identification of groups exerting positive influences for metrication; a description of extent and kinds of teacher training undertaken; a summary of major instructional strategies; and a review of training materials development and usage. Specific problems in metric education are identified and coping strategies are described. These include problems of: resistance to change; inadequate materials; equipment conversion; teacher training; vocational training; communication and coordination; and policy and schedule difficulties. How respondents in each country would change their approach to metrication, if they had the opportunity, is summarized.

Finally, nine major recommendations for how these experiences of other countries can be utilized by the U. S. are presented.

INTRODUCTION

Early History of Metric Conversion

What is commonly referred to as the metric system is a product of the French Revolution; however, attempts in similar directions had been made as early as the 16th century both in France and elsewhere. In 1586, for example, Simon Stevin (1548-1620), a Dutch mathematician, published a pamphlet dealing with decimal fractions and advocating decimal coinage and decimal weights and measures. Historians have generally recognized Gabriel Mouton (1618-1694), vicar of St. Paul's Church in Lyons, as the "founding father" of the metric system. In 1670, he generalized some of Stevin's proposals and suggested a comprehensive decimal system using as a basic measure the length of an arc of one minute of a great circle of the earth.

The striving for a measurement system based upon the physical universe continued in France until in 1795 an act was passed legalizing the metric system with a new unit of length, a metre, equal to one ten-millionth of the length of a quadrant of the earth's meridian. It was not until 1840, however, after considerable controversy and confusion with two systems of measurement, that the metric system became compulsory, with a fine for those found guilty of using other weights or measures. Other countries converted on a more gradual and steady basis until, by the end of the 19th century, the metric system had been adopted by most of the other European nations and most of South America. Within the past fifty years, the Soviet Union, China, Japan and India have adopted it for their every-day measures. Current estimates are that approximately 90% of the world's population reside in countries that have gone metric or are in the process of converting.

In this country the argument over whether the metric system should be adopted as the single official system of weights and measures is perhaps one of our longest continuing controversies, dating back to the administration of George Washington. Historically, the metric controversy has been characterized by high levels of emotionalism and by "more intense and virulent prose than an attack on the sanctity of motherhood (Donovan, 1970, p. 80)." Demagoguery played a major role in the controversy and, particularly in the 19th century, heated arguments pitted the alleged atheistic basis of the metric system against the "divinely ordained" Anglo-Saxon system. That the metric system is a foreign system and therefore to be shunned is an argument that has persisted into the 20th century. Dire effects upon individuals were predicted should metrication occur in this country. Mayer (1924, p. 649) wrote: "Unquestionably, the confusion and waste resulting from the efforts of adults to grow accustomed to new habits, new terminology, and new valuation would carry with it incalculable opportunity for fraud and deception."

A complete history of this controversy is documented in detail in a recent U. S. Department of Commerce publication (1971a). The change is suggested by the following statement in a recent report by the Department of Information of South Africa (1969, pp. 15-16): "A radical change, such as is the conversion to the metric system, occurs perhaps only once in the life of a nation. It is a change affecting every man, woman, and child. A whole new vocabulary, a new 'jargon,' will come into use."

In spite of such controversy, in 1866, the U. S. Congress enacted a law which made the use of the metric system legal but not mandatory; and in 1893, the Secretary of the Treasury issued an order to establish the international metre and kilogram as "fundamental" standards of length and mass for the U. S. The customary standards, the yard and the pound, were defined as definite ratios of the metric standards. While these were promising actions from the standpoint of metric proponents, conversion to the metric system in a practical way was far from achieved.

Recent U. S. Experience

Over recent years proposals to examine the feasibility of U. S. conversion to the metric system have periodically been introduced in Congress. However, it was not until 1965, the year of the British conversion announcement, that such proposals received serious attention. In that year, bills were introduced in both the Senate and the House of Representatives and extensive committee hearings were conducted. Although passed by the Senate, the Metric Study proposal did not receive action by the House and died with the adjournment of the 89th Congress. The effort was renewed in 1967 and during the second session of the 90th Congress, the following year, a bill was enacted.

The Metric Study Act (PL90-472) became law on 9 August 1968. The major impact of this law was the creation of the U. S. Metric Study conducted by the National Bureau of Standards which attempted to report the views of representatives of business, labor, trade associations, consumer groups, educators and the professions, as well as the general public, toward metric conversion. Heavily influencing the initiation of the study, as well as its conduct, was the fact that the English-speaking countries of Britain, Australia, New Zealand, South Africa, and Canada--virtually the last holdouts, except for the U. S.--were beginning to implement plans to convert to the metric system.[1]

The Metric Study Group concluded that eventually the United States would join the rest of the world in the use of the metric system and that it would be in the best interest of this country to effect such a change under a coordinated national program. This was truly a landmark study. It resulted in the recommendation by the Secretary of Commerce, in 1971, that the U. S. make a firm commitment to a coordinated national program of conversion to the metric system and that early priority be given to educating all Americans to think in metric terms (U. S. Department of Commerce, 1971b). The experience gained in this study has served as a rich resource for subsequent Congressional activity.

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[1] Throughout the remainder of this report the term "metric system" refers to the International System of Units (SI). A description of this international metric system is contained in Appendix A

While violent hostility toward the idea of metric conversion may have subsided in this country, negativism nevertheless remains. A survey of public attitudes, part of the U. S. Metric Study, revealed in 1970 that 59% of the respondents thought it was a bad idea for the U. S. to adopt the metric system, while 25% thought it was a good idea (U. S. Department of Commerce, 1971e). While the testimonies of consumer experts were in general favorably disposed toward conversion to the metric system, potential problems of animosity, confusion, increased costs and the need for consumer protection were cited (U. S. Department of Commerce, 1971d).

In March of 1972, hearings were held in the Senate on SB2483 which was then pending in the Senate Commerce Committee, while the House Joint Resolution 1092, the Administration's proposal, was before the House Committee on Science and Astronautics. In a rather surprising move, the Senate unanimously approved a metric conversion bill on 18 August 1972. The bill passed was essentially the same one as that sponsored by the Administration. It established a Metric Conversion Board and required that this board submit to the President and the Congress a comprehensive plan to accomplish a changeover to the metric system in the United States. No such action was taken in the House of Representatives, and consequently the bill died with the closing of the Congressional session.

The 93rd Congress saw the introduction of twelve metric bills in the House and one in the Senate, along with two joint resolutions. While Congressional committee hearings were held on the various metric bills well into the latter period of 1973, the year ended without any definitive action on the part of Congress. The generally positive attitude of Congress and the fact that metric conversion is one of the President's priority pieces of legislation would indicate that a bill should be passed and signed sometime during 1974.

Legislative activity is underway in a number of states, including Hawaii, California, Massachusetts, Minnesota, New Jersey, Maine, North Dakota and Wisconsin. In California, for example, four Assembly bills and an Assembly joint resolution were introduced in April of 1973. Little in the way of major legislation at the state level is likely to be passed, however, until after federal action is taken.

State departments of education are also becoming increasingly active in the metric arena. For example, the Hawaii State Department of Education, in cooperation with the University of Hawaii, is currently sponsoring the development of teaching materials for grades K-6, and the first trial use of the K-3 materials will commence in February 1974. A pilot test is scheduled for fall 1974. Based on the results of the pilot tests, an implementation plan will be developed.[2] Hawaii Senate Resolution No. 235, issued in January 1973, states the objectives of these efforts:

> . . . BE IT FURTHER RESOLVED that the Department of Education prepare itself so that there can be smooth and speedy implementation of the metric system as the primary language of measurement in the public schools upon positive finalization of the pilot project; . . .

The Maryland State Board of Education has directed the Superintendent of Schools to prepare a plan to convert to the metric system over a six-year period beginning in the fall of 1974 (Washington Post, August 30, 1973, p. B1).

In April 1973, the California State Superintendent of Public Instruction announced that, subject to the approval of the State Board of Education, by the fall of 1976 the new state mathematics and science textbooks will have all measurement instruction in metric units (Newsweek, May 7, 1973, p. 65).

In November 1973 the South Carolina State Department of Education sponsored a meeting in Columbia, attended by 180 persons who heard discussions and proposals for a commitment to move toward metrication in the public schools. In early 1974 regional workshops on metrication will be conducted by State Department of Education personnel (Metric News, January/February 1974, p. 13).

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[2] Personal communication, George R. Ariyoshi, Acting Governor of Hawaii, December 31, 1974.

In addition to government-sponsored plans, progress in industry is quickening to the point where the question of will the U. S. convert has very largely been replaced by the questions of how and when conversion will take place. Ford Motor Company, General Motors, and IBM have all announced plans for metric conversion. The commitments of these corporate giants, while anticipating metric legislation, are not contingent upon such legislation. Their announced action will obviously have a tremendous impact on their thousands of suppliers and will very likely serve as a catalyst to many other corporations.

The impact of metric changeover upon education will also be significant. A discussion of educational impact is presented next.

Impact of Metric Conversion on Educational Practices

Undoubtedly, one of the areas of activity that will be most affected by metrication is that of education. While formal classroom education comes first to mind, the massive problem of educating (and motivating) the adult, non-school population cannot be overlooked. In recognition of this problem a component of the U. S. Metric Study dealt with education. This effort was carried out through a campaign of visits, interviews, and telephone conversations with a wide variety of people in education (U. S. Department of Commerce, 1971c). An education conference was also held as part of the overall Metric Study at which position papers were presented by representatives of some 30 organizations concerned with various levels of education.

The results of these two efforts represented a noteworthy first step in supplying information concerned with the educational aspects of metrication. Some of the information presented was well grounded in experience; e.g. the finding:

> Despite the enthusiastic support of organized education, the current usage of metric measurement in elementary science and mathematics is very limited. Its increase is confined to the new science curricula which now reach about 10 percent of the students in grades K-9 (U. S. Department of Commerce, 1971c, p. 7).

On the other hand, many of the findings and conclusions were of a general nature or were matters of opinion with little, if any, grounding in research; for example, the statement that "teachers should spend from 8 to 15 hours in learning the metric system and some teaching tactics (U. S. Department of Commerce, 1971c, p.3)."

Among the general conclusions of the Education Substudy were:

> Unless we have some strong national direction, coordination, and guidance in education, the U. S. may anticipate delays and difficulties, particularly in elementary education. With the help of the test makers, secondary education will take care of itself and the problem of going metric in occupational education is largely the problem of the occupations themselves (U. S. Department of Commerce, 1971c, p. 4).

For its role as part of a sweeping investigation of the metric question, the Education Substudy, and indeed the entire U. S. Metric Study, must be recognized as a landmark effort for U. S. policy determination. Nevertheless, to form a basis for specific plans and programs in American education, more comprehensive studies and research must follow.

There has been very little in the way of educational research conducted on the metric system. The report of the National Science Teachers Association at the Metric Study Education Conference stated: "Apparently, little is known about the problems that students in this country have in learning the metric system or about the best ways of teaching and learning the metric system (U. S. Department of Commerce, 1971c, p. 102)." Their report further states that the ERIC Clearinghouse for Science and Mathematics Education had completed a literature search on teaching and learning the metric system. Only 11 articles, a pamphlet, and two dissertations since 1944 were produced. While admittedly this had been a "cursory" search of the literature, it was judged that "a complete search on this topic would not likely contribute many more sources of information (U. S. Department of Commerce, 1971c, p. 103)." Very few of these references reflected research findings, and even these are of questionable relevance to the educational problems of today.

Yorke, for example, studied the compulsory usage of the metric system in certain European and South American countries. Based largely on her survey in 1938, along with the results of a 1919 survey of U. S. manufacturers by Halsey, she concluded that the metric system "should not be taught as a basic system which will ultimately replace our present one (Yorke, 1944, p. 351)." Johnson, using basically the same data plus the results of his own 1936 survey on the use of metric measures, contradicts most of Yorke's conclusions and concludes that "the best we can do is to teach the simplicity of the metric system in our schools (three units only, the meter, liter and gram) and avoid teaching the conversions (Johnson, 1944, p. 592)."

An interesting indication of coping with suggested metrication took place in the field of American psychology. At the 1969 spring meetings of the American Psychological Association Council of Editors and Publication Boards, it was voted to adopt the metric system in all APA journals and to require that by January 1970 all references to physical measurements follow the metric system (American Psychological Association, 1969). In the interval between January 1970 and June 1971, not one manuscript accepted and published had met this requirement. In commenting on the situation, the following rather naive explanation was offered:

> It is clear that authors should have been provided with more information than that provided by a single reference, and, therefore, . . . we shall attempt to provide information and guidelines to assist authors to comply with the instructions of the editor and the publications board (American Psychological Association, 1971, p. 1099).

In 1972, a computer search of references on the metric system in the ERIC document collection was conducted at the request of AIR, using the services of the USOE regional office in San Francisco. Of the eight references identified, only two were based on research. Murphy and Polzin (1969) reviewed reports dating back to 1929 and concluded that studies suggest that the metric system should be taught at the grade school level and the English system should be de-emphasized. They conclude further that research studies in the area of measurement and the metric system are few. The only other research-based reference (Fineblum, 1970) surveyed the application of the metric system for educating exceptional children and recommended exclusive use of the metric system for this group.

The need for further educational research is emphasized by the National Science Teachers Association, whose report to the U. S. Metric Study concludes: "Therefore, governmental and private agencies should lend early support to research efforts related to means by which metrication can be best accomplished at all grade levels and for preservice and inservice workshops (U. S. Department of Commerce, 1971c, p. 103)."

From the standpoint of both efficiency and economy, the planning of such research should capitalize freely on the experiences and research findings that may already exist in the countries currently undergoing metric conversion. We are presented with what is essentially five nationwide experiments. Each is a replication of the same general treatment, but with notable differences in method and schedule. We are particularly fortunate in that all experiments occur in English-speaking countries. An enormous investment of time and resources is being made by others to implement this great change. For a modest investment we may utilize these experiences in a most profitable way as an adjunct laboratory. It was the recognition of this opportunity that gave birth to the present study.

The primary rationale for the study is to make effective and timely use of experiences occurring in response to changing the measurement systems in five other countries: the United Kingdom, Australia, South Africa, New Zealand and Canada. Systematic study of these living laboratories should supply valuable source data for designing of research programs and planning of educational action programs to reduce the human problems associated with conversion to the metric system.

OBJECTIVES

Specifically, the major objectives of this exploratory study were as follows:

1. To review the process of metric conversion underway in selected foreign countries in order to identify the attendant educational problems of coping with this major social change.
2. To examine the educational changes being made in the countries under study to facilitate the conversion from English to metric measures, including new organizational patterns, communication techniques, and instructional strategies and materials.
3. To relate the steps being taken to facilitate metrication to the progress and problems exhibited in the countries under study.
4. To make recommendations concerning how the experiences of countries engaged in metrication can best be utilized in the U. S. for reducing the potential educational problems associated with conversion to the metric system.

PROCEDURES

A four-pronged approach was employed to obtain the most up-to-date, comprehensive and balanced picture of metric conversion and its impact on education in the United Kingdom, Australia, South Africa, New Zealand and Canada. In general, the approach can be categorized as follows:

- Creation of overseas data collection network
- Design of information storage system
- Intensive literature search and analysis
- Direct survey of key organizations.

Creation of Overseas Data Collection Network

For several years prior to the start of the present study the Palo Alto office of the American Institutes for Research had been engaged in establishing contacts with countries undergoing metric conversion. Correspondence was initiated directly with key representatives of the appropriate board or commission in each of the five target countries. In every case valuable advice was received. Particularly helpful were the many suggestions and the background information received from South Africa.

As a result of these contacts we began to receive copies of the periodic newsletters from each board as well as a multitude of relevant reports, handout materials, brochures, etc. Based upon the suggestions received from our overseas contacts and from a continuing review of the materials they were providing, our information network began to expand at an increasing rate. Our list of organizations and individuals potentially valuable for further contact similarly expanded rapidly.

In anticipation of possible support for a more systematic study of metrication progress in other countries, we began to search for overseas representatives. It was planned that ultimately these individuals would serve as coordinators for more extensive data collection efforts. We were especially concerned that these coordinators would be professional behavioral scientists, skilled in the conduct of social science research and capable of devoting a portion of their time to the collection of information or to the supervision of data collection teams. With such a network, we could be assured of quality information with a minimum of overseas travel expenses. An additional requirement was that any representatives we would employ should be independent of the organizations charged with metric conversion in order to ensure a reasonable degree of objectivity in our information gathering.

As a result of these efforts, upon the award of the current grant we were able to select professional representatives in the U. K., Australia and New Zealand who met our criteria fully. We were especially fortunate in the first two countries to have former AIR staff members agree to serve as our coordinators. The representative in the third country came highly recommended by former staff. In all cases, the senior representatives are university professors with special interest and experience in relevant research areas. Appropriately trained support staff are available to assist the coordinators in each country. In South Africa there was no need for a direct representation as one of our present AIR staff is a South African and still maintains communication with his native country. In fact he was able to schedule a visit to South Africa during 1973 in connection with other business. During this trip contacts were made which further assisted the project. Similarly, for Canada no effort to recruit a special coordinator was necessary due to the nearness to the U. S. and the early stage of their conversion plans.

In addition to establishing formal relationships with our overseas representatives, immediately upon the receipt of NIE support we also accelerated our information search activities based upon the many leads provided in our earlier contacts.

Design of Information Storage System

At the start of this exploratory study we were already in possession of an extensive and diverse collection of relevant publications as mentioned previously. Recognizing that this collection would grow significantly, a major problem faced was the design of a system to organize and store the material efficiently while enabling rapid access.

The design of an ideal information storage and retrieval system was considered best approached as an evolutionary process. As more and different types of information were received and as more demands were placed on retrieving special types of information, the structure of the files was modified. File modification, in fact, continues to the present, and is expected to continue as more experience is gained. Our current overall file design is as follows:

1. General
    - a. Background
    - b. Other countries not in study
2. Business and trade
    - a. Effects on internal economy
    - b. Effects on export trade
3. Industry
    - a. Conversion costs
    - b. Standards
4. Technical
    - a. Scientific standards
    - b. Conversion tables
5. Education
    - a. Primary
    - b. Secondary
    - c. Vocational
    - d. Universities and colleges
    - e. Adult
        - (1) Retraining of working adults
        - (2) Consumer

f. Industrial training

g. Educational material (for all categories)

(1) Devices

(2) Books

(3) Films

(4) Recordings

6. Consumer
   - a. Wearing apparel
   - b. Cooking
   - c. Health
   - d. Home repair
   - e. Packaging and sizing
   - f. Pricing effects and unit pricing
   - g. Sports and recreation
   - h. Transportation
   - i. General
7. Bibliographies and publication card file
   - a. U. S. Metric Association
   - b. Industrial Training Board Publications
   - c. Metric Standards
   - d. National Aeronautics and Space Administration
8. Legislation
   - a. Federal legislation
   - b. State legislation
9. Anti-metrication activities
10. Anecdotes and cartoons

No attempt will be made to describe the content of each of the above files or the sources of information in each, since there is so much overlapping of subjects within a publication. Instead, a list of the major sources of information, along with a few examples, pertaining to all subjects is provided below:

1. Metric Board publications:
    a. Newsletters
        (1) New Zealand Metric Advisory Board Newsletter
        (2) Australian Metric Conversion Board Newsletter
        (3) South African Metrication News
        (4) British Metrication Board, "Going Metric"
    b. Memos
        (1) New Zealand Metric Memo series
        (2) "Going Metric" guides (Great Britain)
        (3) "Metric Information" series (Australia)
    c. Circulars
    d. Progress reports
    e. Timetables

2. Standards Organization publications
    a. British Standards Institution
    b. South African Bureau of Standards

3. Newspaper clippings
    a. United Kingdom and other countries
    b. U. S.

4. Journal articles
    a. Trade and vocational
    b. Technical
    c. Professional

5. Popular magazine articles

6. Questionnaire responses

7. Nongovernmental publications
    a. Commercial newsletters
        (1) Metric Information Service (Great Britain)
    b. Commercial journals
        (1) Metric News (Swani Publishing Co., U. S.)
        (2) Metric Reporter (American National Metric Council)

8. Personal communications
   a. Representatives of Bureaus of Standards
   b. Representatives of Departments of Education
   c. Innovators of individual school projects
9. Educational materials
   a. Texts
   b. Self-instructional materials
   c. Games
   d. Conversion devices
   e. Training aids and equipment
   f. Educational kits
   g. Audiovisual materials

Intensive Literature Search and Analysis

To ensure the most comprehensive information base for this project report a major literature search and analysis effort was undertaken. In the U. K this search was initiated by a Palo Alto staff member temporarily located in Great Britain during the summer of 1973. The remainder of this search was conducted by overseas staff,as was the search in Australia and New Zealand. Copies of reports and articles particularly relevant to the study were forwarded to Palo Alto. In the case of South Africa and Canada, reference lists were obtained from individuals not part of the project staff.

It was recognized early in the project that the pervasive nature of metrication problems and the necessity of monitoring such events as they happen required information sources over and above conventional reports. Accordingly, in the hopes of capitalizing on these sources of information relevant to metric education, a commercial metric information service and a foreign news clipping service were utilized. While the two organizations are located in Britain, both supplied information from other countries as well. In addition, regular review of the London Times was conducted, particularly the feature columns and letters to the editor.

As the materials were received they were reviewed by the study data manager who noted any potential sources of new information identified in the publications and circulated relevant material to other project staff. Following these reviews the material was stored for later intensive analysis during the report preparation phase.

Direct Survey of Key Organizations

Instrument Design

At the same time that the literature search was underway, a data collection instrument was being designed for use in surveying (either by interview or by mail) key representatives of major overseas organizations associated with the metric conversion program in education. This instrument was prepared in draft, reviewed by selected AIR professional staff, and revised accordingly. It was then reviewed by both our British and Australian representatives. One of our prime concerns here was to ensure that the wording of the items conveyed the meaning to our foreign respondents that we had originally intended. Our South African staff member reviewed the instrument for intelligibility in that country.

The final version of the data collection instrument requested information in the following major areas of concern:

1. Sequence of steps taken by agency or association to introduce metric conversion into education.
2. Groups exerting a major influence for the introduction of the metric system in education.
3. Groups resisting metric education, if any.
4. If faced with resistance in connection with metric education efforts, the action, if any, taken to overcome this resistance.
5. Problems the agency has faced in its metric education efforts.
6. Expected and actual schedule of major events that have occurred related to agency's program of metric education.
7. Strategies or approaches that have been highly effective in teaching children or adults metric units.
8. List of materials for metric system education considered especially useful and/or creative.
9. Steps agency has taken in respect to teacher training in the metric system.

10. Specific things agency should do differently if it were faced with the opportunity to begin preparation for metric education all over again. Specific suggestions as to what other agencies or associations should do differently.

11. Names and addresses of schools or other institutions doing a particularly noteworthy job of education in the metric system.

12. Comments on the overall organization that has been developed to foster metric conversion in education, including aspects that appear particularly effective or ineffective.

13. Names of organizations or individuals conducting research or evaluation studies of the process and/or progress of metric conversion.

14. Suggestions on how the U. S. could benefit from the metrication experience in their country.

15. Samples of reports and educational materials that might be especially helpful to educators in the U. S.

Survey Sample

In keeping with the exploratory nature of the study and the very limited resources, the direct survey was generally limited to two types of organizations: (a) nationwide agencies responsible for the conversion program in education, their major subordinate elements and related organizations, both governmental and nongovernmental, and (b) major organizations and societies whose primary membership is directly concerned with metric education.

The identification of the organizations to survey was a joint activity, with the Project Director specifying the general types of organizations along with several specific examples, and the on-site representatives supplying the names and addresses of organizations best meeting the stated specifications. While this was admittedly a limited segment of respondents, it was felt that from a cost-effectiveness standpoint, responses from this group would supply information of greatest value and within budget constraints. Furthermore, it was planned that the tapping of these upper echelon information resources would provide the basic foundation for structuring more penetrating and detailed studies closer to the school and classroom level and would identify particularly valuable information sources for such future research.

Two different distribution strategies were employed due to the nature of our foreign staff resources. In the U. K. and Australia, a single box of questionnaires, forwarding envelopes and return envelopes was shipped to each of the survey teams for individual mailout. It was the responsibility of the coordinators to mail out the questionnaires, maintain records of survey returns and initiate followups on nonrespondents in accordance with a model letter provided by the Project Director. As completed questionnaires were accumulated, they were forwarded to Palo Alto, along with such other materials as had been gathered in the interim. The questionnaires for South Africa and New Zealand, and their followup letters, were mailed directly from Palo Alto--in South Africa because we had no staff representative on site, in New Zealand due to the late date of availability of the on-site coordinator.

Because of the early stage of Canada's metrication program, no questionnaires were sent to agencies in that country. Rather, in order to obtain an overall picture of Canada's program plans and to accumulate relevant materials, a visit was made to the Canadian Metric Commission and to the Department of Consumer and Corporate Affairs, and interviews were held with key staff. Followup correspondence was conducted both with these individuals and with sources of information identified during the visit.

Table 1 presents a breakdown of the number of organizations contacted in each country and the number of usable responses received. A list of organizations represented by the respondents is included in Appendix B. Considering the type of organization surveyed and the depth of the information requested, the response rate was considered acceptable, except for New Zealand where problems in locating a survey coordinator and in identifying the organizations to be contacted delayed the survey to the point where responses have just recently begun to arrive. The number of publications and other documents from New Zealand were ample, however, for purposes of the current study.

TABLE 1

Summary Data on Organizations Contacted and Responding

Country	No. of Questionnaires Distributed	Responses Received	Response Rate
United Kingdom	70	36	51%
Australia	36	15	42%
South Africa	34	14	41%
New Zealand	32	6	19%*

*Questionnaires still being forwarded.

In addition to the literature review and the mail survey, site representatives in the U. K. and Australia conducted supplemental interviews where valuable information and additional informational materials were obtained. In subsequent sections of the report the products of all of these information-gathering strategies are integrated and discussed.

The next section provides an overview of the approach to metrication in the five target countries. The recent metrication history in each country is discussed along with the organization developed to coordinate the program and its schedule and overall approach. Following this the findings of the study which have greatest import for U. S. education are presented. This section is organized by major issues and problems and, within each issue, the information from all five countries is analyzed and discussed jointly. The final section presents an overall summary of the implications of this exploratory study for U. S. education along with recommendations for specific action.

OVERVIEW OF METRICATION IN SELECTED COUNTRIES

United Kingdom

Recent History

The contemporary phase of British metrication dates from the Report of the Committee on Weights and Measures Legislation (the Hodgson Committee) submitted in December 1950. This committee had been established by the President of the Board of Trade to examine the issues of weights and measures in great detail. In their report, the committee unanimously concluded that: the metric system was a better system of weights and measures than imperial; a conversion from the imperial to the metric system was sooner or later inevitable for all trade purposes; a continuance of the option to use either the metric or imperial system until the inevitable came about would cause, in the long run, more inconvenience than an ordered change within a specified period; and the long-term advantages which would flow from an organized change in the near future would far outweigh the inconveniences of the change itself. Two important provisos were stressed in the Hodgson Report: that the change should only be done in concert with those countries of North America and the Commonwealth which based their units on the yard and the pound; and that, prior to metric conversion, the currency should be decimalized (Report of the Committee on Weights and Measures Legislation, 1951).

British industry and commerce were opposed to the conversion at that time, mainly because of the continued adherence to the imperial system by most of the Commonwealth and by the United States, Britain's biggest market for exports. Nearly ten years later, in 1960, a committee was appointed jointly by the British Association for the Advancement of Science and the Association of British Chambers of Commerce to consider whether or not it was desirable to adopt a decimal system of coinage and a metric system of weights and measures. The report showed that a majority of industry was still opposed to a change to metric units, although the committee recognized that the world trend was towards the metric system and recommended that the situation should be reviewed every two years (Metrication Board, 1970).

A shift in the balance of opinion became quite apparent in 1963, when the British Standards Institution published the results of a wide consultation with industry. A large majority was now shown to be firmly in favor of initiating a change to the metric system without delay and without waiting for the rest of the Commonwealth and the United States. Reinforcement of this assessment occurred in 1965 when the President of the Federation of British Industries informed the Government that a majority of the members of the Federation, both in the number of firms and in the total size of their business, was in favor of the adoption of the metric system as the primary and ultimately the only system of weights and measures to be used in Great Britain. By this time most of the Commonwealth nations and former British colonies had decided to convert to the metric system; the USSR was adopting SI (International System of Units); and China used the metric system.

On 24 May 1965, the President of the Board of Trade gave the Government's response in a statement in the House of Commons. A portion of that statement follows:

> The Government are impressed with the case which has been put to them by the representatives of industry for the wider use in British industry of the metric system of weights and measures. Countries using that system now take more than one-half of our exports; and the total proportion of world trade conducted in terms of metric units will no doubt continue to increase. Against that background the Government consider it desirable that British Industries on a broadening front should adopt metric units, sector by sector, until that system can become in time the primary system of weights and measures for the country as a whole. . . . (Hansard, 1965).

Early in 1966, the Minister of Technology established the Standing Joint Committee on Metrication. One major task of the Committee was to coordinate Government and industrial policies and to make recommendations to the Minister in cases where more positive Government action was required; another was to encourage all sectors of the economy to start planning for metric conversion.

After considering a number of specific problems relating to metrication in industry, including the implications of such a change for education, legislation and Government purchasing, a recommendation was made to create a Metrication Board to facilitate the conversion process.

In response to the committee report given to the Minister of Technology in June 1968, he announced the acceptance of that report in a statement to the House of Commons on July 26 including the establishment of a Metrication Board "as soon as possible" (Hansard, 26 July 1968).

Organization

The Metrication Board was established and held its first meeting in May 1969, under the chairmanship of Lord Ritchie-Calder.

At this meeting the decision was made to set up eight committees to assume responsibilities for the most important sectors of British economy. They were:

1. Agriculture, Forestry, Fisheries and Land
2. Distribution, Food and Consumer Goods Industries
3. Education and Industrial Training
4. Engineering Industries
5. Fuel and Power Industries
6. Industrial Materials and Construction Industries
7. Transport and Communication Industries
8. Information Policy

Each committee was chaired by a member of the Board, who was supported by at least one other Board member, of which there are seventeen in number. Each committee member was chosen for his or her special qualifications and not as the representative of a particular group or organization. In the words of the first Metrication Board report, the members were chosen from "people of standing, who had an interest in changing to the metric system . . . (Metrication Board, 1970, p. 18)." In addition, a staff organization of six divisions was formed. The Board operates with a staff of 67 people. The original organization of committees, also referred to as steering committees, and staff divisions are displayed in Figure 1.

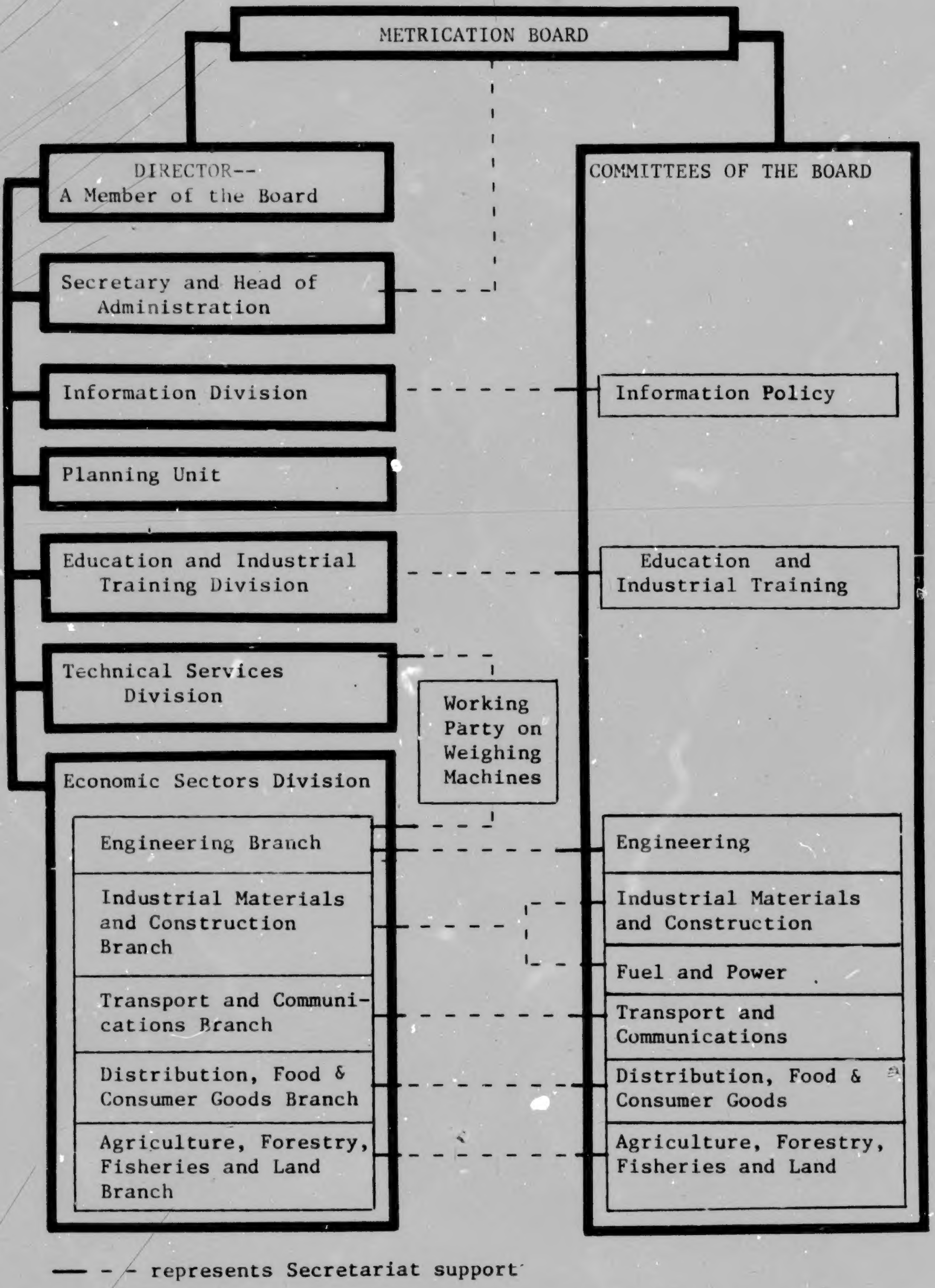
METRICATION BOARD
DIRECTOR--
A Member of the Board
Secretary and Head of Administration
Information Division
Planning Unit
Education and Industrial Training Division
Technical Services Division
Working Party on Weighing Machines
Economic Sectors Division
Engineering Branch
Industrial Materials and Construction Branch
Transport and Communications Branch
Distribution, Food & Consumer Goods Branch
Agriculture, Forestry, Fisheries and Land Branch
COMMITTEES OF THE BOARD
Information Policy
Education and Industrial Training
Engineering
Industrial Materials and Construction
Fuel and Power
Transport and Communications
Distribution, Food & Consumer Goods
Agriculture, Forestry, Fisheries and Land
— - - represents Secretariat support

Figure 1. Organization of the British Metrication Board
(Metrication Board, 1970)

The organization of the Board has not changed markedly during the ensuing years. The original Committee on Distribution, Food and Consumer Goods Industries was expanded to two committees: (1) Distribution and Consumer Interests, and (2) Consumer Goods Industries. In December 1972, a Consumer Safeguards Group was established to make recommendations on "practicable means of enabling consumers to judge value for money during the period when both imperial and metric are in use . . . (Metrication Board, 1973, pp. 12-13)."

The National Union of Teachers noted with regret that only one representative of education was on the Metrication Board and that the Committee on Education and Industrial Training had no teacher representatives (National Union of Teachers,1971).

Organizations which are concerned with metrication in a particular industry were encouraged to communicate with the appropriate committee through the Secretariat.

The current Chairman of the Board is Lord Orr-Ewing. The Baroness White is the Deputy Chairman. The Board is advisory, with no compulsory powers.

In the first report submitted to the Government, entitled Going Metric, The First 5 Years, 1965-69, the Board stated.

> Britain will be a metric country before 1975. In 1965 the Metrication Decade was launched. At mid-term, the progress made confirms that forecast and justifies the confidence placed on voluntary initiative. . . . The country is now advancing in a broad front towards its metric objectives (Metrication Board, 1970, p. 9)

Subsequent statements have been more muted.

Schedule for Education

Within the general overall target date of 1975, no firm schedule was set by the Metrication Board for educational conversion. Schools were exhorted to keep fully informed of developments throughout Great Britain and to keep pace with or exceed the conversion schedules of individual industries.

The primary schools were given the charge to start training at once in SI at a level so that primary students would "think in SI units." It was recommended that instruction in imperial measures should be continued on a temporary basis, in the nature of second language training. No clear time directives were given to secondary education, examining bodies for education, or adult and vocational education. Those responsible for school curriculum had already developed preparatory measures for metrication by the time the Board was functioning.

The Royal Society, which is very influential in science education, called a national conference in March 1968. The conference provided the following opportunities: (1) school staff heard industry's timetable; (2) there was a discussion among teachers in all areas of university personnel so that an agreed policy could be reached and disseminated; (3) consideration was given to the materials that would be required; and (4) organization of in-service preparatory courses for teachers was started.

The Schools Council, an independent body with considerable influence on curriculum, developed several guides to metrication which were widely disseminated throughout Great Britain. In 1968, Change for a Pound, a teaching guide for currency and metrication was prepared by the Council's Mathematics Committee. In 1970, the Council's Crafts, Applied Science and Technology Committee published Measure for Measure: A Guide to Metrication for Workshop Crafts and Technical Studies; and in 1971, the Council's Primary Committee collaborated with the Steering Committee for Education and Industrial Training of the Metric Board to produce, for the primary schools, Metres, Litres & Grams.

The Department of Education and Science in 1968 invited all relevant bodies concerned with exams to consider the changes that they needed for metric conversion and how these changes could be introduced.

By 1971 many of the technical examining bodies were publishing exams in metric as well as English measures, and a number of exams had become fully metric. The academic area examining boards substantively completed conversion in 1972-73, with a large share of their exams requiring the use of metric units. The schedule followed by the Oxford Delegacy of Local Examinations is illustrative:

1. Announced to the schools in 1968 the intention to change to SI units.
2. Physics: advanced level converted in 1970,
   ordinary level converted in 1971
3. Chemistry: converted in 1972.
4. Other Sciences: converted in 1972.
5. Mathematics: advanced level converted in 1971,
   ordinary level - increasing emphasis in metric units from 1972; some questions will remain in imperial until the country no longer uses them.
6. Technical Subjects:
   Drawing converted in 1970.
   Engineering - advanced level converted in 1970.
   Crafts - a 5-year period with choice of papers in either the imperial or metric systems (1970-74) with complete conversion in 1975.
7. Home Economics: candidates may use either imperial or metric units. Conversion in 1976.
8. Geography: converted in 1973.[3]

Primary education accepted the original Metrication Board's charges, and conversion appears to have been completed in most primary schools by 1972.

Training institutes report that they have kept up with the demands from various industries and the examining boards. The individualized, laissez-faire approach in Great Britain has led to large differences in the schedule of industrial conversion among different sectors of industry. In addition to the unevenness of progress in conversion, a loss of momentum appeared in 1971-72. Some industries which had gone ahead rapidly had suffered financial losses and to some extent recoiled. Loss of momentum was felt strongly by the schools. Educators also felt that the progress in the schools was well ahead of that in the country as a whole. The lack of commitment outside of education, i.e. by the public and retail trade areas, was obvious to students and became a severe hindrance to effective in-school instruction in practical applications.

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[3] Personal Communication from E. M. Shaw, Senior Assistant Secretary, 1973.

General Approach and Progress in Metrication

Among the more important policy decisions guiding Great Britain's efforts were:

1. No compensation for conversion; the costs must "lie where they fall."
2. The target of 1975 was a "soft target," with the provision that if this was "unreasonable" for a given sector, the program for that sector would be aimed at an earlier or later date.
3. Industrial and commercial conversion, and to some degree education, received major early emphasis. Programs in the construction industry, engineering, the electrical industry, and the marine industry were among the first established.

During 1970, many plans and programs drawn up in earlier years were implemented, further industrial programs were announced and educational changes took place. The issuance of metric standards by the British Standards Institution aided in overcoming earlier problems arising from the absence of essential metric standards. Educational leaders, examination bodies and educational publishers greatly assisted the changes already taking place in schools and colleges. More public attention was being devoted to the conversion due to more interest being shown by the national press and an increase in debates in Parliament.

The interest in metrication was also stimulated by the decimalization of British currency.

The period covered by the Board's Second Report, entitled Going Metric: Progress in 1970, however, began to show signs of a bumpy road ahead:

> . . . There are still some areas in the national economy where little progress has yet been made and there are some firms which are still hanging back in the belief that somehow and in some way the changeover to metric will be reversed. Any encouragement to delay or to contracting out could be damaging. The leaders of industry are very concerned that the present momentum should be maintained. They are apprehensive that the delay could lead to a loss of this hard-won momentum. Once lost, this would be difficult to regain. They are concerned too that a slowing down in the rate of change would, with the consequent dislocation and lengthening of the transitional period, be very costly to the economy, not least because of the continuing need to work in both systems and because the period during which dual stocks would have to be held would be lengthened. They have drawn attention to the need to respond to the expanding demand for metric products in overseas markets and the dangers of falling behind the rate of change in some of our major markets. They have stressed that industry cannot go forward in isolation and that the changes in industry must be accompanied by changes in education and training, distribution and retailing and by the wider use of metric measures in daily life (Metrication Board, 1971, pp. 2-3).

During 1971, the external factors increasing the urgency of conversion were intensified. Change overseas was spreading and its rate accelerating. Another major factor was the successful outcome of the negotiations for membership in the European Economic Community and the decision of the Government, subsequently endorsed by Parliament, that Britain should join the EEC.

However, in spite of these pressures demanding an acceleration of the rate of conversion, there was a loss of momentum in 1971. This was accounted for by a lowering of the level of industrial activity, a shortage of cash and a decline in the rate of industrial investments. A decline in confidence in the desirability of pressing forward with conversion set in, reinforced by the increasing doubts as to whether the Government continued to favor metrication. These doubts were fervently encouraged by those who opposed metric conversion.

The Metrication Board's report for 1971, entitled Going Metric: Looking Ahead, stated:

> . . . Only the Government can give the positive lead which is essential to restore confidence and recover the buoyancy and energy which is necessary if metrication is to resume its advance on a broad front as a coherent national policy. . . . An effective information effort to aid consumers must necessarily depend on a clear statement of policy by the Government and of their intention to safeguard the interests of consumers by legislation or otherwise (Metrication Board, 1972, p. 13).

A White Paper on metrication, considered by both critics and proponents of metrication to be long overdue, was finally presented to Parliament by the Secretary of State for Trade and Industry in February 1972. This document affirmed the target date of 1975 for completion of metrication as a realistic goal, although recognition was made of the fact that, in some sectors, it might be necessary to postpone full metrication until a later date. The White Paper stated:

> The move to metrication has been taking place over many years, but the Government believe that the time has now come when they must act to ensure the orderly completion of the process. In doing so they will not hesitate to take whatever steps are necessary to protect the consumer during the period of changeover and to reduce to a minimum any difficulties which the introduction of the new system may cause (Department of Trade and Industry, 1972, p. 3).

The White Paper is generally cautious and claims for success are qualified. As one reviewer described it, "The British Government is keeping its head low on metrication."

It should be noted that no parliamentary legislation with respect to metrication had been passed during this period. The entire British conversion has been accomplished through cooperation between Government agencies and private groups.

Opponents of metrication in Great Britain refer to the process as "conversion by stealth." They have long been accusing the Government of stealth and trickery in foisting a foreign system of weights and measures upon the unsuspecting public. In answer to these critics the White Paper stated:

> There is nothing new about using the metric system in the United Kingdom; it is not some sudden innovation or recent discovery. It has been lawful here for all but a few purposes, at least since the Weights and Measures (Metric System) Act of 1897. So there can be absolutely no question of "metrication by stealth"; nor is there any lack of parliamentary authority for the way it has been becoming more generally adopted. This has been a gradual process, proceeding item by item, and that is the way it will continue (Department of Trade and Industry, 1972, p. 2).

The Government decision in January 1973 to join the European Economic Community (EEC) lent impetus to the metrication program. In a European Community Council Directive of 18 October 1971, all member states are required to use SI units (International System of Units), such use being permanently prescribed after 18 October 1976.

The overall target date of 1975 for completion of metrication in Great Britain appears doubtful. However, some sectors of the British economy will probably attain it.

News releases, pamphlets, touring exhibitions and films, and speeches by the Metrication Board and staff members have comprised the major information techniques. By 1971, two films had been produced, both on industrial conversion. Pamphlet distribution ran approximately 60% to business and industry, 15% to education, and 25% to the general public. Later, a quarterly bulletin, Going Metric, was started with a readership that was primarily industrial. National conferences organized by the Metrication Board in 1971 were directed to industrial materials, building, and engineering.

The Board was criticized for not giving sufficient guidance to the public. In 1972, Metric Memos, approximately one per month, were produced in addition to the quarterly bulletin. Leaflets directed more towards the consumer were produced, as well as a 92-page paperback on the Advantages of the Metric System (Ede, 1972). In 1973 a film designed for the general public, "Simply Metric," was produced and displayed throughout the country. A newspaper advertising campaign begun in 1972 was addressed to business managers. The need for a campaign addressed to consumers was acknowledged by the

Metrication Board in 1973. However, to date the effort does not appear extensive.

Despite the overall neglect of dissemination to the public, the current Chairman of the Metrication Board, Lord Orr-Ewing, occasionally responds personally in local letters to the editor columns--answering criticisms of the Board or of metrication. There is no lack of such criticism in Great Britain. An informal count of letters to the editor, based on clipping services in Great Britain, indicated approximately 60% opposed, 40% pro-metric.

The Metrication Board has placed consumer education as a priority target for 1974. Project plans include: advertising, making films available, library bookmarks, information board posters and leaflets. The Metrication Board hopes to organize a series of meetings with senior journalists, especially those with women's magazines. As yet, the Consumers' Association does not appear to deal with metrication at all in its consumer education program.

The Metrication Board now hopes that complete metrication will be the rule by 1979. However, it looks as if this may be delayed even more. Education of the consumer is lagging badly. Historically, educators have felt real concern that the uneven and slowed progress might signal a halt to metrication. The National Union of Teachers presented its concerns and position in Metrication: No Turning Back (1971). In this report they urged the passage of legislation to go metric in the fullest sense in a speedy and orderly manner. The union's position paper highlighted the following progress in education:

1. The Government had failed to make financial provision for the local educational authorities to prepare for the change.
2. Primary schools had committed themselves to metrication and many had completely converted.

3. Colleges and Departments of Education had committed substantial resources to teacher training in metrics.

4. Considerable effort had been made in in-service training by teacher groups, LEAs, and teacher centers.

The N.U.T. policy statement argued that education had progressed substantially--past the point of no return--by July 1971.

Educational representatives in Great Britain have felt that their progress has been ahead of the general progress of the country, particularly in the retail sector and consumer-related industries. The Schools Council Primary Math Project conducted a survey in 1973. Conclusions with respect to metrics were: All schools seem to have taken metrication in their stride. Positive comments were cited: "Speeded the primary course by at least one year"; and "In general made teaching easier and stimulated many children who found math a difficult subject." In retrospect, it appears that British education could, and did make an urgent effort to convert. In fact, they have been accused in the press and by certain members of Parliament as directing the conspiracy to force metrication upon the country (The Bookseller, March 1971, p. 1662).

If the lack of attainment of the 1975 national goal becomes a reality, it will not be due to the sloth or heel-dragging of British education.

Australia

Recent History

In 1967 the Australian government appointed the Senate Select Committee on the Metric System of Weights and Measures, which made an extensive survey of the practicability and desirability of early adoption of the metric system. Responses were received from more than 150 associations, organizations, and government departments as well as from numerous individuals. Support for the change was expressed by educators, industrial representatives, retailers, consumer organizations, professional organizations and government. It is interesting to note that even where the change was not supported it was almost universally accepted as being inevitable.

Against this background of overwhelming support for the change to the metric system, the Minister for Education and Science introduced the Metric Conversion Bill in the Commonwealth Parliament in March 1970. The bill's object was to bring about progressively the use of the metric system of measurement in Australia as the sole system of measurement of physical quantities.

Debate in both the House of Representatives and the Senate was favorable and the Metric Conversion Act of 1970 received Royal Assent on 12 June 1970. The Act:

- Extends to all territories of the Commonwealth except the Territory of Papua and New Guinea. (An Ordinance of Papua-New Guinea, No. 78 of 1970, assented to on 19 October 1970, makes a similar provision to that of the Metric Conversion Act.)
- Defines the metric system of measurement for conversion purposes so that units to be used can be specified explicitly.
- Provides for a Metric Conversion Board to make recommendations to the Minister aimed at attaining the objects of the Act, and to exercise powers and functions authorized by the Minister.

- Empowers the Minister to make arrangements and enter into agreements which he thinks conducive to attaining the objects of the Act (Metric Conversion Board, 1971b).

As provided for in the Act, a Metric Conversion Board of thirteen members was appointed on 1 July 1970, and its first meeting was held 4 July 1970. The number of members was increased to fourteen in July 1971. The Board is responsible to the Minister for Education and Science for the conduct of the conversion. Its overall function is to help plan, guide and facilitate the nation's conversion to metric. Specifically the main task of the Board is to help ensure the success of conversion in different sectors and to coordinate conversion programs through close consultation with and between the parties concerned.

The functions and powers conferred on the Board by the Minister are:

- To advise on the need for legislation to give effect to conversion.
- To disseminate and make available appropriate information and advice.
- To collect and analyze relevant data.
- To keep under review and report to the appropriate authorities any attempts to take unfair advantage of the public in the course of conversion.
- To set up committees to report to the Board on specific aspects of conversion.

The government made it clear that "the metric change would be predominantly a voluntary one, planned and implemented by those who will themselves be affected by it (Metric Conversion Board, 1972, p.8)."

Organization

The Board consists of members drawn from all States of the Commonwealth and experienced in many of the sectors in which conversion will be effected. Included in the membership are the Chairman of the Commonwealth Interdepartmental Coordinating Committee for Metric Conversion and the Chairman of the States' Committee for Metric Conversion.

In opening the Board's first meeting, the Minister for Education and Science stressed that members should regard themselves not as representing sectional interests but as part of a coherent body concerned with the single concept of metric conversion, prepared to approach its problems on a national basis. He indicated that as far as possible the programs for conversion in different sectors should be coordinated and priorities allocated on the basis of optimum use of natural obsolescence and depreciation in the value of plant and equipment to limit conversion costs. A second goal was that conversion as a whole be effected to the best advantage of the community.

As one of its first major tasks the Board established a committee structure to assist in the development and implementation of the conversion programs. In order to do this, they identified all the major activities within the community likely to be affected by metric conversion and grouped them so that each activity would have a committee responsible for formulating its timetable for conversion.

Altogether the Metric Conversion Board set up eleven advisory committees, each chaired by a Board member, which control some 80 sector committees comprising over 600 experts in all areas impacted by metric conversion. Sector committees comprising nominees from appropriate organizations, national associations and institutes, and government departments were established to cover relatively coherent groups of activities. Members do not serve as representatives of their nominating bodies, but are appointed because of their expertise in a relevant area. An organization chart of the Metric Conversion Board and its committees is presented in Figure 2.

The Education and Industrial Training Advisory Committee was established with sixteen members. In selecting members, attention was given to all education authorities and to the major interest areas of education. These groups

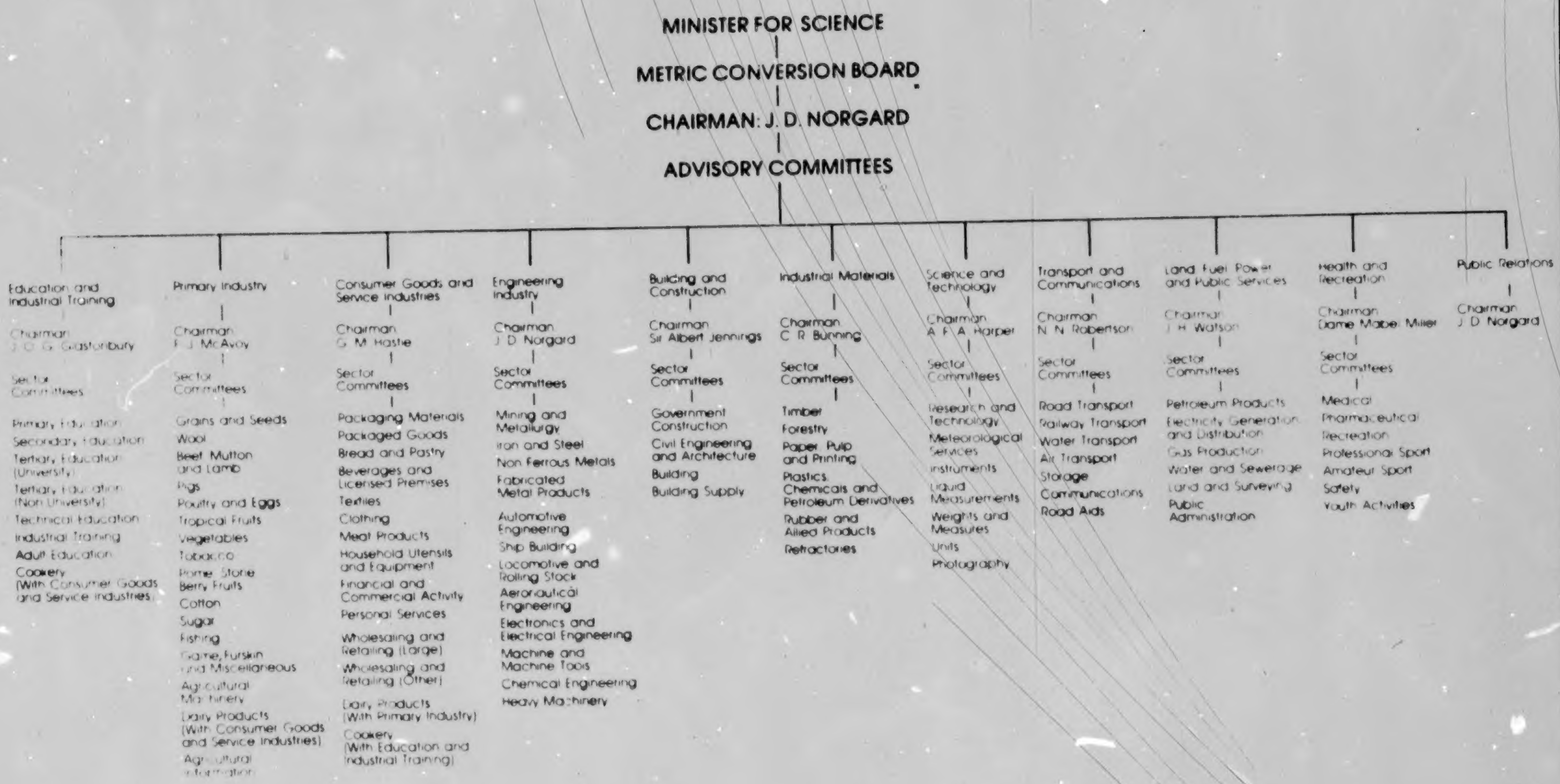

MINISTER FOR SCIENCE
METRIC CONVERSION BOARD
CHAIRMAN: J. D. NORGARD
ADVISORY COMMITTEES
Education and Industrial Training
Chairman J. O. G. Glastonbury
Sector Committees
Primary Education
Secondary Education
Tertiary Education (University)
Tertiary Education (Non University)
Technical Education
Industrial Training
Adult Education
Cookery (With Consumer Goods and Service Industries)
Primary Industry
Chairman F. J. McAvoy
Sector Committees
Grains and Seeds
Wool
Beef Mutton and Lamb
Pigs
Poultry and Eggs
Tropical Fruits
Vegetables
Tobacco
Pome Stone Berry Fruits
Cotton
Sugar
Fishing
Game, Furskin and Miscellaneous
Agricultural Machinery
Dairy Products (With Consumer Goods and Service Industries)
Agricultural Information
Consumer Goods and Service Industries
Chairman G. M. Hastie
Sector Committees
Packaging Materials
Packaged Goods
Bread and Pastry
Beverages and Licensed Premises
Textiles
Clothing
Meat Products
Household Utensils and Equipment
Financial and Commercial Activity
Personal Services
Wholesaling and Retailing (Large)
Wholesaling and Retailing (Other)
Dairy Products (With Primary Industry)
Cookery (With Education and Industrial Training)
Engineering Industry
Chairman J. D. Norgard
Sector Committees
Mining and Metallurgy
Iron and Steel
Non Ferrous Metals
Fabricated Metal Products
Automotive Engineering
Ship Building
Locomotive and Rolling Stock
Aeronautical Engineering
Electronics and Electrical Engineering
Machine and Machine Tools
Chemical Engineering
Heavy Machinery
Building and Construction
Chairman Sir Albert Jennings
Sector Committees
Government Construction
Civil Engineering and Architecture
Building
Building Supply
Industrial Materials
Chairman C. R. Bunning
Sector Committees
Timber
Forestry
Paper, Pulp and Printing
Plastics
Chemicals and Petroleum Derivatives
Rubber and Allied Products
Refractories
Science and Technology
Chairman A. F. A. Harper
Sector Committees
Research and Technology
Meteorological Services
Instruments
Liquid Measurements
Weights and Measures
Units
Photography
Transport and Communications
Chairman N. N. Robertson
Sector Committees
Road Transport
Railway Transport
Water Transport
Air Transport
Storage
Communications
Road Aids
Land, Fuel, Power and Public Services
Chairman J. H. Watson
Sector Committees
Petroleum Products
Electricity Generation and Distribution
Gas Production
Water and Sewerage
Land and Surveying
Public Administration
Health and Recreation
Chairman Dame Mabel Miller
Sector Committees
Medical
Pharmaceutical
Recreation
Professional Sport
Amateur Sport
Safety
Youth Activities
Public Relations
Chairman J. D. Norgard

Figure 2. Organization of the Australian Metric Conversion Board (Metric Conversion Board, 1973a, p. 13)

were asked to provide a short list of nominees which were then selected by the Board to provide a maximum degree of experience in various geographical regions among the education authorities. Although it was emphasized to each person that he was not serving on the committee as a representative of any region or group, this overlap among associations with both regions of the country and areas of education was chosen so as to maximize the degree of contact between committee members and various bodies involved in education and industrial training. For example, a member from Tasmania had extensive contact with home economics education associations, while a member from West Australia was involved with adult education. Teachers' unions were not members of the committees at this stage, but their representatives were consulted after policy had been recommended but before it had been approved.

These committees were advisory; however, according to our survey, they did serve as useful forums for exchange of information, establishment of consensus of opinion, and recommendations for policy and action by the appropriate agencies. Information and advice for teachers often came directly from organizations established at the state level. For example, within the Education Department of Victoria a policy committee for metric conversion existed as well as curriculum committees for the various subjects at the different levels of education.

Assisting the Education and Industrial Training Advisory Committee are seven sector committees, each covering a specific area of education: primary education, secondary education, tertiary (university) education, tertiary (non-university) education, technical education, adult education, and industrial training.

The Tertiary (Non-University) Education Sector Committee is concerned with all tertiary institutions other than the universities. Members are drawn from the colleges of advanced education, institutes of technology, and teacher training and agricultural colleges, with each state having at least one representative. Paramedical colleges which are also within the purview of this committee are already largely metric.

The responsibilities of the Technical Education Sector Committee (composed of nominees of each state's Director of Technical Education) extend beyond technical schools, which train apprentices, technicians and technologists, to the commercial correspondence and business schools. Membership on the Committee primarily represented public education, with members drawn from as many states and disciplines as possible, to provide funnels of information. Each individual acted as a channel to more than one area. While there are some private technical schools in Australia, it appears that they were not involved closely in any cooperative effort relative to the impact of metric conversion, possibly because of the competitiveness that exists among these schools.

The Adult Education Sector Committee consists of a number of adult educators, one or more from each state, and as of 1971 was engaged in developing courses and teaching aids and methods, and testing the effectiveness and suitability of these on sample populations.

An illustration of the overlapping nature of committee structure is a committee entitled "Cookery" which is a joint committee reporting to both the Education and Industrial Training Advisory Committee as well as the Consumer Goods and Service Industries Advisory Committee.

Schedule for Education

Similar to Great Britain, metrication in Australia will not have a single "M Day" either for the start of conversion or for its completion. Instead, each sector is expected to develop a program appropriate to its circumstances, taking into account related activities in other sectors. The integration of these schedules is facilitated by the structure of the Sector and Advisory Committees. A chart of tentative and confirmed dates of conversion in major areas of the economy is periodically updated and published. In general, the current schedule calls for the years 1973-1975 as the time of major implementation with 70% completion for Australia as a whole by 1976.

After consultation with state education ministers, the Minister for Education and Science confirmed the Board's recommendation that curricula in primary schools should become fully metric as early as possible in 1973 and that a start in metric conversion should be made in secondary schools as soon as possible and not later than 1973, with the aim that secondary schools be solely metric by the commencement of the 1974 school year. It was assumed that a significant saving in time required to teach the school curricula would result when only metric units were taught. This expectation was based upon the simplicity of the metric system, and it is expected to be realized only when teaching in imperial units is discontinued. The prospect of such a saving provided the argument for an early, rapid and complete conversion. At the postsecondary level the schedules were not so optimistic, but it was assumed that the various institutions beyond the secondary level would be primarily metric by 1976. It appears that the metric conversion program in general, and education in particular, has been on schedule or perhaps slightly ahead of schedule.

During the 1970 period and much of 1971, the Educational and Industrial Training Advisory Committee and its sector committees were involved in planning programs for conversion; however many individual institutions and teachers had already realized that the value of future teaching in the imperial system was limited. Many teachers had started to plan and implement their metric education and industrial training programs even before the conversion programs were confirmed. As a result, a number of schools in Australia commenced teaching in metric units during 1972; while some universities, colleges of advanced education, and institutes of technology introduced metric units into the first year of some of the courses they offered, in preparation for complete conversion in subsequent years.

The conversion program recommended by the Technical and Tertiary (Non-University) Education Sector Committees began with planning activities in 1971-72 and implementation from 1972 onwards. A rather lengthy conversion program in some subjects was anticipated because of the conversion of engineering and mechanical equipment, and a large amount of material for correspondence courses which would need conversion, as well as lecture notes and worksheets. Nevertheless, conversion is expected to be largely completed by 1976. As of the Second Annual Report of the Metric Conversion Board for the year 1971-72 (Metric Conversion Board, 1973b), no official conversion program had been developed for universities, very likely because of the automony of universities and of individual lecturers in determining the content of their lectures. However a notice, intended to alert members of staff to the changes that will require consideration, had been distributed widely throughout the universities as well as to colleges of advanced education, institutes of technology, teachers' colleges and similar educational establishments. The Australian Vice Chancellor's committee conducted a survey of the extent of metrication in universities during the fall of 1973. As yet we have not received a report on the results of this survey.

Concerning progress in the area of education, the members of the Primary Education Sector Committee reported in 1973 that conversion at that level had gone extremely well, to the point where some children were using metric concepts in everyday speech. Progress towards completion of conversion in the secondary schools by the beginning of 1974 was encouraging. It appeared that conversion here would be on time without major difficulties. The members of the Technical Education Sector Committee reported that despite financial constraints, conversion in technical education was proceeding smoothly and on schedule with no evidence that the program had to be revised to allow more time for conversion; but, on the other hand, a few programs had been accelerated by the pressure of events. The overall opinion was that education was leading industry (MCB Newsletter, November 1973).

Metric conversion courses were offered by several adult education centers in 1972 but without drawing significant enrollment. It was assumed that the reason for this apparent lack of interest was probably the fact that metric conversion would not start to affect the general public until late in 1972 or early in 1973. However the Board's 1971-72 report noted that many adult educators had introduced metric measurement in courses on other subjects (Metric Conversion Board, 1973b).

General Approach and Progress in Metrication

Australia's Metric Conversion Board, very likely benefitting from the U. K. experience, recognized that establishing and maintaining a high level of communication with the general public was a crucial element in the successful implementation of metric conversion. The plan was first to create an awareness of the imminence of conversion and to develop a climate favorable to the change through an understanding of why Australia was metricating and what it would involve. A prime goal was to overcome any apprehension regarding the change. Following this, the need was recognized for information appropriate to particular conversions as they arise, such as the conversion to Celsius temperature.

For particular sectors of activity, it was recognized that more specific problems of communication exist, including the initial assessment of whether a suggested conversion program is appropriate and acceptable to those whose work is in or peripheral to the sector, the dissemination of information about the agreed-upon program, the coordination of the supply and demand of metric materials or components, and the identification and solution of potential difficulties before they reach major proportions.

The major vehicle for stimulating an awareness for metrication was the Board's initial publication, Metric Conversion for Australia, which appeared in June 1971 (Metric Conversion Board, 1971b). Following this, the Board initiated a publication program of brochures, booklets, posters, pamphlets and leaflets to increase public awareness and to provide instructional aids and information in specific areas. The Board had the benefit of advice from its Public Relations Advisory Committee which included senior representatives of newspapers, radio, T.V. and advertising organizations. Most of the leading newspapers gave assurances of support for metric conversion, and nearly every media organization nominated a staff member to be responsible for reporting on metric matters and to provide direct liaison with the Board's Director of Public Relations.

An important medium for the dissemination of metric information is the MCB Newsletter, a monthly tabloid newspaper. This publication excels in both newsworthiness and eye appeal. Beginning with 6,000 copies in November

1971, circulation had grown to 13,000 by June 1972 (Metric Conversion Board, 1973b).

Plans called for a shift in emphasis of the Board's public relations program in 1972-73 from public awareness to public involvement. Typical of this shift were the conversions of horse racing (1 August 1972) and weather reporting (1 September 1972). These were deliberately chosen as model operations because they will be typical of a number of other changes to follow. In the words of the 1971-72 Metric Conversion Board Annual Report:

> While virtually the whole community will be involved to some extent, their impact will at no time be intense and they are not expected to create public disquiet; indeed the Board believes these changes should do much to demonstrate that, taken step-by step, the public will be able to cope with metric conversion just as competently as it did with currency conversion (Metric Conversion Board, 1973b, p. 47).

Preceding the conversion there was an intensive education, publicity and public relations campaign with a minimum period of dual units. This was in keeping with the principle accepted by the Board that learning "to think metric" is hindered rather than helped by the use of dual statements in conversion tables. (The Board continues to admonish the public not to compare or convert between metric and imperial.) It was concluded that these initial conversion efforts have helped tremendously in getting the public to think anew, and together with decimalization of currency seven years ago they have "primed a mass of people without causing an upheaval."

As already noted, Australia's conversion to the metric system has been marked by a number of attractive publications aimed not only at instructing the general public but at gaining their support. One of the most eye-appealing leaflets from the Metric Conversion Board shows on its cover the picture of Shane Gould, Olympic swimming champion and "Australian of the Year." Under her picture is the caption, "Let's give mum and dad a hand in understanding the metric system." Inside the leaflet is a handwritten letter which indicates the problem that Australian Olympic competitors have had in the past competing over metric distances and then coming home and being surrounded by feet and yards. But fortunately for Shane, swimming was metric in Australia for as long as she could remember, and she raises the question, "Where would I be if I had to train in Australia over yards and compete in Munich over metric distances?" Miss Gould recognizes that, while learning the metric system is easy for young people, it will not be as easy for their parents.

In the meteorology field, one of the first targets for public conversion, brochures have been published to educate the reader on the importance of the various aspects of meteorology and to provide an understanding of why, for example, barometric pressure is important. Little space is devoted to justifying why there is need to convert to metric in this area. Instead, there is the simple statement that Australia is becoming a metric nation and that as of the first of September temperatures will be measured in degrees Celsius, replacing degrees Farenheit. It states:

> The Australian Government has decided that metric conversion should be achieved by 1980. Together with all sections of government and private enterprise, the Bureau of Meteorology is effecting the change as soon as possible (Commonwealth Bureau of Meteorology, 1972, p. 1).

So much for justifying the change.

In early 1973 the Australian Post Office issued four seven-cent stamps to commemorate Australia's conversion to the metric system. The stamps were intended to create public awareness of conversion and to draw attention to the four aspects of the metric system which people would encounter most frequently--length, volume, mass (weight), and temperature. According to the Postmaster General, the cartoon-style stamps "humanized" the subjects and created interesting visual messages which emphasized how conversion would affect people's daily lives. The stamps were not universally accepted in a favorable light, however. For example, the Sydney Sun stated:

> The Post Office has produced some frightful stamps. Here's one to lick the lot. It shows a blobby cartoon figure of a man on a stool swilling back a glass of beer. It is one of four equally nauseating works of non-art to mark Australia's change to the metric system (MCB Newsletter, February 1973).

The Temperance Society also objected to this particular stamp. The Sunday Sun (Brisbane) took the opposite position stating "Here's something to brighten up those dull old pages of first-day covers . . . (MCB Newsletter, February 1973, p. 1)." The New York Times School Weekly in a half-page feature described the stamps as "ingenious" and adds:

> Australia had chosen not the stylized image but an all-out cartoon technique to humanize and give meaning to the philatelic messages that emphasize how metric conversion affects people's daily lives. But the stamps are more than cartoons; they are funny cartoons--which gives them added point (MCB Newsletter, May 1973, p. 4).

Figure 3 presents copies of these stamps for the reader to judge.

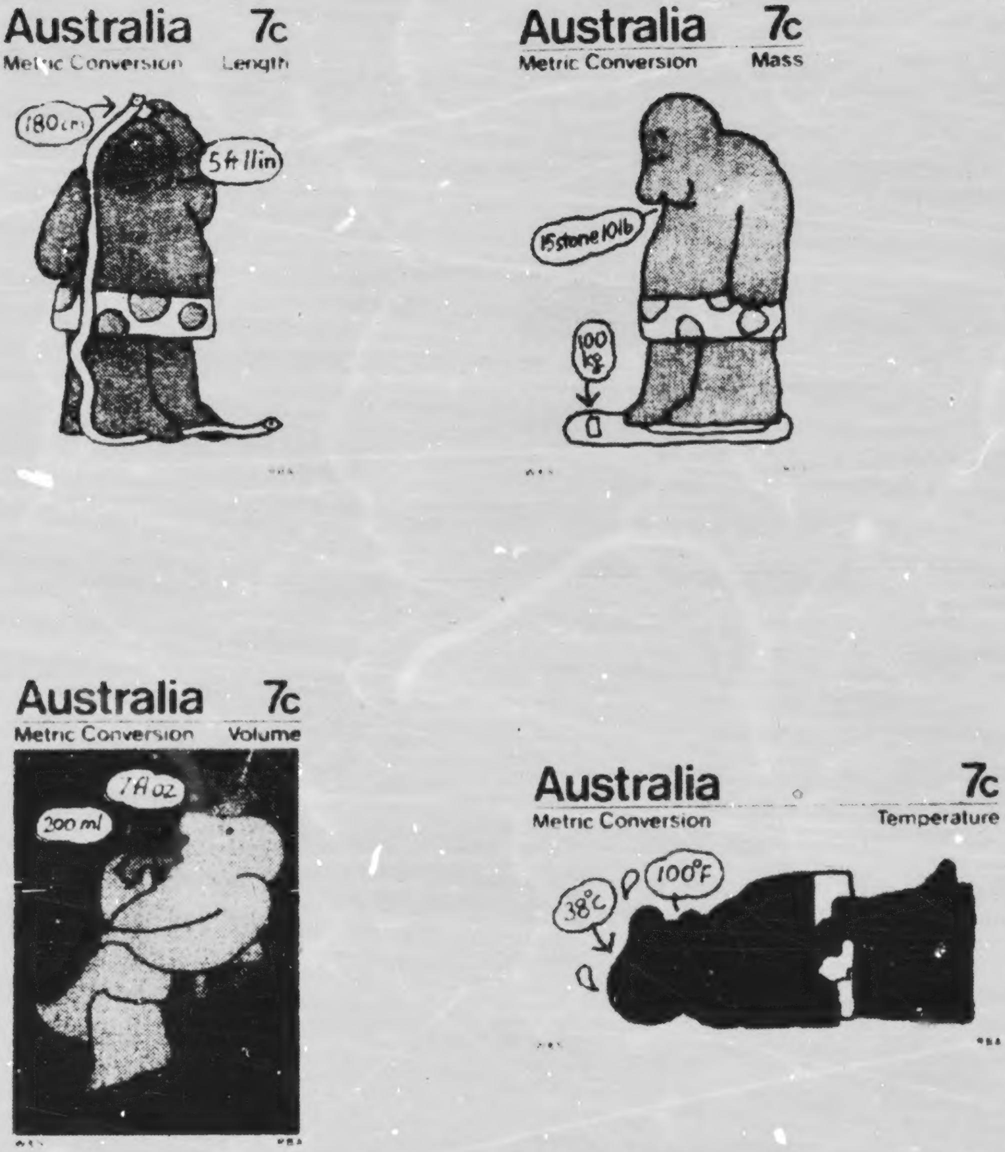

Australia 7c
Metric Conversion Length
180cm
5ft 11in
Australia 7c
Metric Conversion Mass
15 stone 10 lb
100 kg
Australia 7c
Metric Conversion Volume
7 fl oz
200 ml
Australia 7c
Metric Conversion Temperature
38°C
100°F

Figure 3. Stamps Commemorating Australia's Conversion to the Metric System

South Africa

Recent History

The Government of the Republic of South Africa, in 1966, decided to replace the imperial system of weights and measures, generally known as the foot-pound-gallon system, with the decimal metric system.

The first serious suggestion that South Africa should adopt the metric system was made by the Board of Trade in 1945 when post-war industrial development was discussed. The suggestion was followed up by a special committee which recommended that the country's coinage should be decimalized, but that no action should be taken in regard to weights and measures. At that time, fears were expressed that a change would hamper the country's business dealings with Great Britain and the United States.

By 1962, the proportion of South Africa's trade with countries using the metric system had increased considerably. There were increasing signs that Britain, still South Africa's main trading partner, was seriously contemplating conversion to the metric system and the argument against a change based on trade was greatly diminished.

A committee was appointed by the Council of the South African Bureau of Standards in 1962 to investigate the practicability and full implications of the adoption of the metric system of weights and measures. The committee came to the conclusion that the change to the metric system would facilitate the expansion of South Africa's foreign trade and that the internal efficiency of the country would be greatly increased.

Organized industry and commerce expressed support for the change, and in 1966 the Minister of Economic Affairs announced that the Government had accepted the principle that South Africa should convert to the metric system. In 1967 it was resolved that the immense task of metric conversion should begin without further delay.

The Minister of Economic Affairs, in 1967, announced the appointment of a Metrication Advisory Board to advise him on policy matters regarding the conversion.

Organization

The Advisory Board is representative of organized commerce and industry, of Government Departments, and other organizations more directly concerned with metric conversion. The following organizations are represented on the Board: the "Afrikaanse Handelsinstituut" (Afrikaans Trade Institute), the Association of Chambers of Commerce, the Federated Chamber of Industries, the Steel and Engineering Industries Federation, the Division of Weights and Measures of the Department of Commerce, the Department of Higher Education, and the South African Bureau of Standards. Two members from each organization are invited to serve on the Board because of their specialized knowledge.

The functions of the Advisory Board are, briefly, to arrange for the conversion in all sectors to be coordinated into an effective national program; to arrange for proper liaison with state and associated organizations, commercial and industrial bodies, and professional institutions; to give advice regarding problems relating to conversion; to examine and correlate timetables for conversion in the different sectors; to issue national programs of conversion periodically; and to plan proper publicity, information and public educational campaigns.

The task of investigating problems, establishing procedures, and planning and coordinating the changeover was entrusted to a separate department established within the South African Bureau of Standards (SABS), due to its normal activities and technical contact with organized commerce and industry. The Metrication Department (MD) started functioning in 1968 with four Divisions: (1) Industrial, (2) Commercial, (3) Publicity, and (4) Miscellaneous Services, dealing with all sectors not falling under (1) and (2), such as education, hospital and health services, surveying and mapping, the Post Office, roads and road traffic, the professions and sports.

Close cooperation among the divisions was required.

The metrication program in commerce deals mainly with the packaging of goods and conversion of weighing and measuring instruments.

The Industrial Metrication Division, understandably, has had the most complex program to plan and oversee. It was found that all economic activities in South Africa could be classified into 119 groups, each group consisting of many industries. For example, the manufacture of metal products includes over 450 separate types of manufacture, not counting the manufacture of machinery.

The Industrial Division's first task was to determine which metric sizes of basic materials, such as bar, rod, sheet, wire, timber, bolts and nuts--articles used by all industries--were to be adapted as national standards and to determine a date for the introduction of such standards. The next step was the formation of technical committees for planning the conversion within groups of industries. Those committees were as follows:

1. Textiles and Clothing
2. Leather and Leather Products
3. Rubber Products
4. Plastic Products
5. Furniture
6. Electric Cables and Equipment
7. Packaging
8. Non-metallic Mineral Products
9. Metal Products
10. Machinery
11. Transport Equipment
12. Building and Construction

Schedule

In July 1970, approximately two years after the broad program for metrication was first announced, the SABS stated "The conversion program is proceeding according to plan and the task is being carried out with enthusiasm. Cooperation has been forthcoming from all sectors and it is anticipated that the Republic will be about 85 percent metric by 1975 (South African Bureau of Standards, 1970, p. 5)."

The timetable for initiation of changeover in primary and secondary education was as follows:

- Grades i, ii and Standard I (Grades 1-3) - Completed August 1969
- Standards II through V (Grades 4-7) - Completed January 1970
- Standards VI through IX (Grades 8-11) - Mathematics, physical science, chemistry, physics and biology completed January 1970
- Standard X (Grade 12) - For same subjects, completed January 1971; the final matriculation examinations in metric units in December 1971.

For applied subjects including woodworking, housecraft, geometrical drawing, geography, etc., Standards VI-VIII changed over January 1970; Standard IX, January 1971; and Standard X, January 1972. In these subjects, final examinations in metric units only were given in December 1972.

The schedule called for metric units only to be used in all schools at the end of 1972. This schedule was met. For the applied subjects the changeover had to be a little more gradual, as indicated above, in order to keep pace with what was happening in the industrial sector. The same pattern was followed in technical high schools, where the argument was that pupils had to be given the opportunity to complete their training in the system of units to which they were accustomed. Nevertheless, the final changeover here took place in 1972. The changeover in the higher education sector in South Africa, for the most part, coincided with that in the primary and secondary sectors.

General Approach

South Africa's metric conversion program has been almost a model of precision scheduling, due to the fact that conversion steps have been largely made by Government decree. For example, a Government edict, published in late 1972, stated that as of 1 August 1973, it would be illegal for any retail merchant to sell certain non-metric measuring instruments and measures (South African Bureau of Standards, September 1972). Infractions were to be punishable by fine, jail sentence or both.

The House of Assembly and Senate of the Republic of South Africa, on 13 and 14 June, 1973, approved the Measuring Units and National Measuring Standards Act. The "Metrication News" commented on the Act as follows:

> The Act, on coming into force, will give legal recognition to all the units that are presently in use in the Republic. It is the intention that, as progress is made with metrication, increasingly more limitations on the use of imperial and obsolete metric units will be imposed, after consulting with the parties concerned, until eventually these units can be deleted altogether. At that stage only SI units, their SI multiples and submultiples and a few other units that are recognized for use with the SI will enjoy legal recognition.
>
> If one thinks of the heated debates that have taken place in the parliaments of other countries on this subject, we can indeed be grateful that the South African Parliament has taken this step without dissent (South African Bureau of Standards, September 1973,p.1).

South Africa's conversion program placed heavy emphasis upon communication. In addition to the use of newspapers, radio and popular magazines, the South African Bureau of Standards (SABS) published a series of approximately 30 guides printed in both English and Afrikaans, designated as the M series. Some titles of these guides are as follows:

1. The Use of the SI in Primary Education (M 27)
2. Metrication for the Family (M 19)
3. Metrication for the Farmer (M 25)

4. Metrication in Local Government (M 10)
5. Metrication for the Typist (M 28)
6. Metrication for Information Media (M 30)
7. Metrication in Hospitals (M 21a)

Many other general information pamphlets and guides of a more highly technical nature, as well as a monthly newsletter "South African Metrication News" were also published by the SABS. These publications were distributed widely among industrial and other organizations to assist them in their internal conversion programs. We have estimated the number of such guides and pamphlets published as almost 100.

The publicity campaign was coordinated with the general progress of the conversion and was extended gradually and systematically to correspond with the conversion process. It was considered essential that the public should be familiar with the system early in the conversion process, and should start thinking in metric terms as quickly as possible.

For that sector of the population employed in industry, training in the metric system was provided by the industries involved, as training programs necessarily varied from one industry to the next. Again, training was programmed to coincide with the actual changeover, so that employees would have the new system fresh in their minds at the time they actually began to use it in the course of employment.

One example of the efficiency of planning for metric conversion in South Africa was the conversion of the railways. This particular conversion was accomplished on February 1, 1972. Speed signs along thousands of kilometres of railroad throughout South Africa and South-West Africa were converted, and locomotive speedometers calibrated in kilometres per hour were brought into use.

Because of the large number of signs involved, work had to be carefully planned to ensure that the safe running of trains was not impaired. The operation consisted of attaching prepainted faceboards onto the existing backing plates which had been accurately drilled to take the new faceboards. This work was completed in one day.

Locomotive speedometers had been previously fitted with metricated dials and were brought into operation simultaneously with the sign changeover. The South African Bureau of Standards reported that the changeover took place without problems "and is an example of how metrication can be achieved smoothly with adequate planning and coordination (South African Bureau of Standards, April 1972, p. 2)."

In discussing the general approach to metrication in education, a brief comparison of terms used in South Africa with those used in the United States is necessary:

South Africa	United States
Grade i & ii	Grade 1 & 2
Standard I-X	Grades 3-12

Metric education in grades i and ii is devoted primarily to building vocabulary; no practical measurement is introduced until Standard I. Prefixes are introduced in Standard II as are decimal notations. In Standard III, decimal notation is used consistently. By Standard IV, the pupil is expected to estimate everyday measurements in metric units. In general, Standard V is a consolidation year, in which the pupils prepare for secondary schools, where much more sophisticated units and derived units will be used.

The interim use of a dual system, where necessary in certain classes, presented no disruptive problem since, for many years, the dual system had been in effect, i.e., physical sciences were metric and other subjects imperial. In those subjects which did not require the use of the dual system, however, teachers were exhorted to use SI only and to approach the changeover as though the imperial system had never existed. Conversion from one system to the other was discouraged as indicated by the following instruction:

> . . . imperial measures may, under no circumstances, be mentioned from 1970 to primary students . . .
>
> A principle which must be heavily underlined, is that primary pupils should discontinue imperial measures altogether, at least in the classroom. In school, pupils should never hear, read or see in print any imperial units. They must be ignored to the extent of no existence. It therefore follows that pupils should attempt no conversions from imperial to metric or vice versa (Department of Education, Windhoek, South West Africa, October 1969, p. 2).

The cornerstones of the metric conversion in South Africa are known as the four "c's" of conversion--consultation, cooperation, coordination and communication (Department of Information, Pretoria, South Africa, 1969). In comparison to other countries' approaches one might well add a fifth "c" here--compulsion.

New Zealand

Recent History

In July 1965, the New Zealand Standards Institute, a division of the Department of Industries and Commerce, compiled a report drawing attention to the consequences of the British decision to convert to the metric system.

In 1966 the newly formed Standards Association (replacing the Standards Institute) set up a Metric Advisory Committee, broadly based and including representatives of Government departments. This committee first met in February 1967 and published a report stating that the adoption of the metric system was inevitable. This conclusion was made known to the Government before publication of the report.

In 1967 the Government appointed a Working Committee of officials to inquire into and report the need for New Zealand to adopt the metric system of weights and measures. The Cabinet, on receving the report of this committee in February 1969, agreed that a Metric Advisory Board should be set up to encourage, advise and assist the progressive, voluntary adoption of the metric system of weights and measures. The Board was subsequently established in 1969 under Section 12 of the 1956 Trade and Industry Act. Members of the Board are appointed by the Minister of Trade and Industry, whose department provides administrative support to the Board (Metric Advisory Board, no date).

Organization

Fourteen Sector Committees were set up by the Board to facilitate the metric changeover. Each Sector Committee is chaired by a Board member and comprises representatives of related organizations who have special expertise. The role of each Sector Committee is to examine the implications of metrication problems, prepare programs, and coordinate the metric program implementation in their respective sectors of the economy and, where appropriate, with other sectors. Wherever appropriate, Divisional Committees have been established to operate in relation to specific areas within sectors. Each Divisional Committee is chaired by a Sector Committee member. The Sector Committees and their respective Divisional Committees are:

1. Agriculture

   a. Grain, Seed and Produce
   b. Horticulture
   c. The Fishing Industry

2. Building and Construction Industry

   a. Modular and Dimensional Coordination
   b. Building Services

3. Central and Local Government

   a. Coordination of Legislation
   b. Local Authorities
   c. Central and Local Government Purchasing and Contracts

4. Education

   a. Universities
   b. Primary, Secondary and Teachers' College Education
   c. Technical Education

5. Engineering and Engineering Servicing Industries

6. Food and Consumer Goods and Services

   a. Consumer Foods
   b. Consumer Textiles and Apparel

7. Fuel and Power

8. Manufacturing and Processing Industries

   a. Clothing, Textiles and Allied Industries
   b. Chemicals and Toiletries
   c. Food Manufacturing
   d. Electrical and Electronic Manufacturing
   e. Building Materials
   f. Printing and Allied Industries
   g. Motor Vehicle Manufacturing and Related Industries
   h. Packaging
   i. Footwear, Leather and Leather Goods

9. Public Relations

10. Recreation and Sports

11. Science and Technology

   a. Units, Symbols and Nomenclature
   b. Scientific and Technical Publications

12. Standardization

13. Transport and Communication
    a. Road Transport

14. Weighing Machines

The Education Sector Committee held its first meeting on 7 April 1970. Its assigned responsibility was to assist in the changeover to metric units in education at all levels. Its functions include:

- Ensuring that educational and technical institutions are informed of metrication planning and development in trade and industry.
- Assessing the training required by industry and the assistance required from the educational system.
- Coordinating the changeover from imperial to metric units in existing curricula and examinations.

Pursuant to the above functions, the committee's membership has been drawn from the universities, technical institutes and both primary and secondary schools. Specific representation was chosen from the Post-Primary Teachers' Association, the Department of Education, the Industrial Training Service of the Department of Labor and the New Zealand Educational Institute.

Schedule

An overall timetable for the introduction of the metric system into educational institutions was established in late 1969 and included the following sections and dates of implementation:

1. Primary Schools and Teachers Colleges
    a. mid-1970 to mid-1972: gradually phase out imperial units and introduce common metric units
    b. mid-1972: teach only the metric system to all pupils and student teachers

2. Secondary Schools

a. beginning 1970-end 1972:
   (1) increasingly use metric units in practical work and comparisons
   (2) School Certificate questions may use imperial or metric units
   (3) University Entrance, Bursary and Scholarship science papers will use metric units only
   (4) Some non-metric units in mathematics papers

b. beginning 1970:
   (1) relate changeover in some technical courses to the change in trades and industries
   (2) all science courses taught in metric units

c. beginning 1973:
   (1) all courses in metric units
   (2) University Entrace, Bursary and Scholarship papers in metric units only

d. 1973: School Certificate, mathematics and science questions in metric units only. Metric and non-metric papers offered in some applied subjects such as technical drawing, woodwork and home economics

e. beginning 1974: metric units only for School Certificate

3. Technical Institutes

Teaching in technical institutes is geared to the following examination schedule:

a. beginning 1972-end 1973: alternative forms of questions for Technician's Certification Authority and Trades Certification Board examinations

b. beginning 1974: Technician's Certification Authority and Trades Certification Board examinations in metric units only

4. Universities

   a. beginning 1970-end 1972: changeover at discretion of universities

   b. beginning 1973: all university teaching and examinations to use metric units only

5. Adult

   a. Vocational and Industrial: since the training of managers, staff and workers in the Industrial Sector depends on the progress of conversion in particular industries, their training necessarily had to follow different timetables in different industries. In general, this aspect of adult education began at the end of 1970 and was planned to be completed by the end of 1976, the goal date set for the completion of the changeover.

   b. Consumer
   The education of the consumer (general public) was primarily the responsibility of the Public Relations Sector Committee. Public awareness and education was planned to fall into three overlapping phases:

      (1) creation of awareness of the coming changeover and ready acceptance to extend into 1972
      (2) creation of understanding of the timing of actual changes proposed and the reasons for them; knowledge of metric units and how they should be used. This phase was already underway at the end of 1972
      (3) involvement by particular sections of the community and the population as a whole, beginning at differend dates according to the timing of any particular change. For some sections of the community, personal involvement had already begun at the end of 1972, such as in the use of the Celsius temperature scale, the sale of wool and milk in metric units, and the introduction of metric road signs.

General Approach

Education assumed a lead role in conversion, and commenced the gradual phasing out of imperial units at the primary level. This was completed and metric units only were being studied by the end of 1972. Many teaching resources were provided or updated by the Department of Education, e.g., new sets of metric assignment cards for use by pupils, special bulletins issued to teachers, and posters for the classrooms. In early 1973, distribution of equipment, filmstrips, and metric versions of textbooks or supplements began.

At the secondary level, metric units were used increasingly in practical work and computations, and were used exclusively in some Schools Certificate papers, notably science and mathematics. Progress was made with the replacement or modification of basic equipment issued to schools. By the end of 1973, the timetable on the secondary level was on schedule.

The Minister of Education gave approval for secondary schools to take the lead in the coordination of metrication retraining activities in their local districts with the establishment of Community Metric Advisory Councils.

Toward the close of 1973, it was realized that the metric change in industry was not yet sufficiently advanced to justify examinations in technical institutes in metric units only. The Divisional Committee on Technical Education (former Divisional Committee on Technical Institutes) made the recommendation, endorsed by the Metric Advisory Board, that dual units be retained in Technician's Certification Authority and Trades Certification Board examinations for 1974, with further review of the situation to be given in mid-1974. This extension of the duality period was deemed to be in the best interest of the students--many of whom would still be using imperial units at their place of employment.

The changeover in the universities had progressed so well during 1972 that the Divisional Committee on Universities had not found it necessary to hold a meeting during that year. After one more scheduled meeting, to enable the representatives of the various universities to compare notes on the changeover, the Divisional Committee on Universities plans to disband.

The Divisional Committee on Technical Education has the task of ensuring that metric retraining is provided for all of those adults for whom the satisfactory transition to the metric system is essential for their livelihood and who need assistance in making the change. Retraining entailing classwork for leading hands (foremen) and above in the manufacturing, engineering and construction trades is offered by technical institutes (or secondary schools providing evening classes), although large firms, local bodies and governmental departments are expected to conduct programs within their own organizations.

For industries such as forestry, agriculture and marine, governmental extension and advisory services have undertaken retraining of supervisory staff and above, including the professional and self-employed.

The technical institutes are well suited, by virtue of their organization, to the provision of new courses to meet local needs. A number of short courses and seminars have been provided in industries such as meat and wool, the freezing industry, building and construction, and transport.

As mentioned earlier, consumer education was the responsibility of the Public Relations Sector Committee. Outlined below are the main types of public relations activities of this committee.

1. News Releases
   a. short versions for daily and weekly newspapers
   b. more detailed versions for trade and technical publications
2. Bulletins and Newsletters
   Basic information on the Board, its structure, the metric system, adopted timetables, etc.
3. Posters
4. Basic Information Folders
   Entitled "Metric Memos" dealing with basic information on the metric system intended for handy reference
5. Lectures
   By the Chairman of the Advisory Board and Secretariat staff and more than 20 members of a panel

6. Film

   A 13-minute, widescreen color film for theatrical distribution titled "Measure for Measure"

7. Displays

   Both static and traveling displays to illustrate metrics in industry and the general economy

8. Give-away Items

   a. calendars
   b. cardboard cubic decimetres
   c. 150 mm rulers
   d. reprints of charts, etc.
   e. "Householder" booklet to be distributed to every householder in New Zealand

9. Television and Radio

   Programs on the NZBC network

New Zealand's program for metrication seems to be on schedule. Mr Ian D. Stevenson, Chairman of the New Zealand Metric Advisory Board, participated in the Commonwealth Metrication Conference held in London in April 1973. On his return, he made the following statements, "I returned to New Zealand convinced that our plans are well laid, as effective as any, and in some respects better than most . . . (Metric Advisory Board, August 1973, p. 2)." . . . "There is no part of our planning where I advocate any change (Metric Advisory Board, August 1973, p. 4)."

Canada

Recent History

Canada's move toward nationwide adoption of the metric system was officially initiated on 16 January 1970, when the White Paper on Metric Conversion in Canada was presented in the House of Commons by the Hon. Jean-Luc Pepin, then Minister of Industry, Trade and Commerce. On this occasion he made these comments:

> Changing to the metric system will have important benefits for the Canadian consumer. These benefits will derive principally from the inherent simplicity in general use. The ease of conversion from one metric unit to another--from kilograms to grams, for example--will simplify the arithmetic in making value comparisons of competitive consumer products.
>
> For these reasons and for many others which are indicated in the White Paper, the Government believes that the adoption of the metric system is ultimately inevitable and desirable for Canada. However, no legislative action is contemplated which would make mandatory a general use of the metric system in place of inch-pound units (Boire, 1973, p. 5).

The Canadian White Paper on Metric Conversion was one of those rare government policy statements endorsed by all political parties.

For approximately 100 years before the submittal of the White Paper to Parliament, Canada had slowly been going metric, as had many other nations. The Weights and Measures Act of 1873, adopted by the Second Parliament, stated that the metric or decimal system might be legally used. " . . . no contract or dealing shall be deemed to be invalid or open to objection, on the ground that the weights or measures expressed or referred to in such contract or dealing are weights or measures of the Metric System . . . (Department of Consumer and Corporate Affairs, 1973a, p.4)."

As in several other countries, in the late 1930's, 35mm cameras and film were becoming popular. The scientific community had been using metric units for the most part since before the turn of the century. The Canadian pharmaceutical industry converted to the metric system in the early 1960's and metric units were universally prescribed by Canadian physicians. Metric conversion in the health and welfare sector was launched by the Canadian Hospital Association in 1966. The estimation has been made that over 75% of all Canadian hospitals are now using metric units for their internal operations while using customary measures in communicating with the public (Boire, 1973).

Three basic principles of accepted Canadian Government policy in the area of metric conversion were identified in the White Paper:

1. "The eventual adoption in Canadian usage of a single coherent measurement system based on metric units should be acknowledged as inevitable and in the national interest.
2. This single system should come to be used for all measurement purposes required under legislation, and generally be accepted for all measurement purposes.
3. Planning and preparation in the public and private sectors should be encouraged in such a manner as to achieve the maximum benefits at minimum costs to the public, to industry and to government at all levels (Government of Canada, 1970, p.8)."

According to the White Paper, the federal government should assume a leading role in the planning and the process of metrication. The flavor of the Paper is reflected in the following statement:

> The Government accordingly accepts eventual conversion as a definite objective of Canadian policy, and proposes means of study and consultation whereby the pace and the methods of change may be determined in the national interest. No legislative action is contemplated which would make mandatory a general use of metric in place of inch-pound units, although some legislation may prove desirable to foster familiarity with metric units (Government of Canada, 1970, p. 5).

The question of Canadian metrication has become more and more a subject of public discussion during the past few years. Considerable coverage in the press has been devoted to the subject and a number of national organizations have voiced their views on metrication before the government with suggestions for action ranging from initiation of studies to immediate adoption. The Consumers' Association of Canada, the Canadian Home and School and Parent-Teacher Federation, the Agricultural Institute of Canada, and the Canadian Chamber of Commerce are among those organizations expressing support for conversion.

In 1968, the Canadian Teachers' Federation passed a resolution encouraging conversion to the metric system. Most provincial departments of education have reported a trend toward more metric teaching (Government of Canada, 1970).

Even though no specific time limit was set for conversion, the White Paper stated that information on the metric system should be made readily available to the public and that introduction of the metric system should be encouraged wherever the benefits were clear and the costs minimum.

Organization

In order to implement these objectives, the Canadian Government established the Metric Commission by Order in Council in June 1971. Their first meeting was held in January 1972. The 17-member Commission, chaired by Stevenson M. Gossage, reports to the Ministry of Industry, Trade and Commerce. The members represent all regions of Canada.

The Metric Commission has the objective of developing an overall national conversion plan. It is organized to help each sector make its own conversion plans and to monitor the progress of the sectors in implementing these plans. As indicated in an early bulletin, the Commission may call upon officers and employees in any department or agency of the government as necessary, or may engage organizations or persons having specialized or technical knowledge for advice and assistance.

The Commission has established 11 Steering Committees, each responsible for the coordination of a group of economic sectors with related interests. Each Steering Committee is chaired by a member of the Metric Commission. The two Steering Committees of prime interest to this report are Number 9, which encompasses consumer services and labor organizations, and Number 10, which covers information, education and training. In addition, an Interdepartmental Committee was formed which is responsible for coordinating metric conversion within the federal government. A complete listing of the Steering Committees is provided in the Metric Commission Bulletin which is reproduced as Figure 4.

The Commission has further established over 60 Sector Committees, reporting to the Steering Committees. Each is responsible for a particular industry, group of industries or interests and is preparing the basic plans for converting the sector for which it is responsible in collaboration with individual firms and associations. The chairman of each Sector Committee is a member of the responsible Steering Committee.

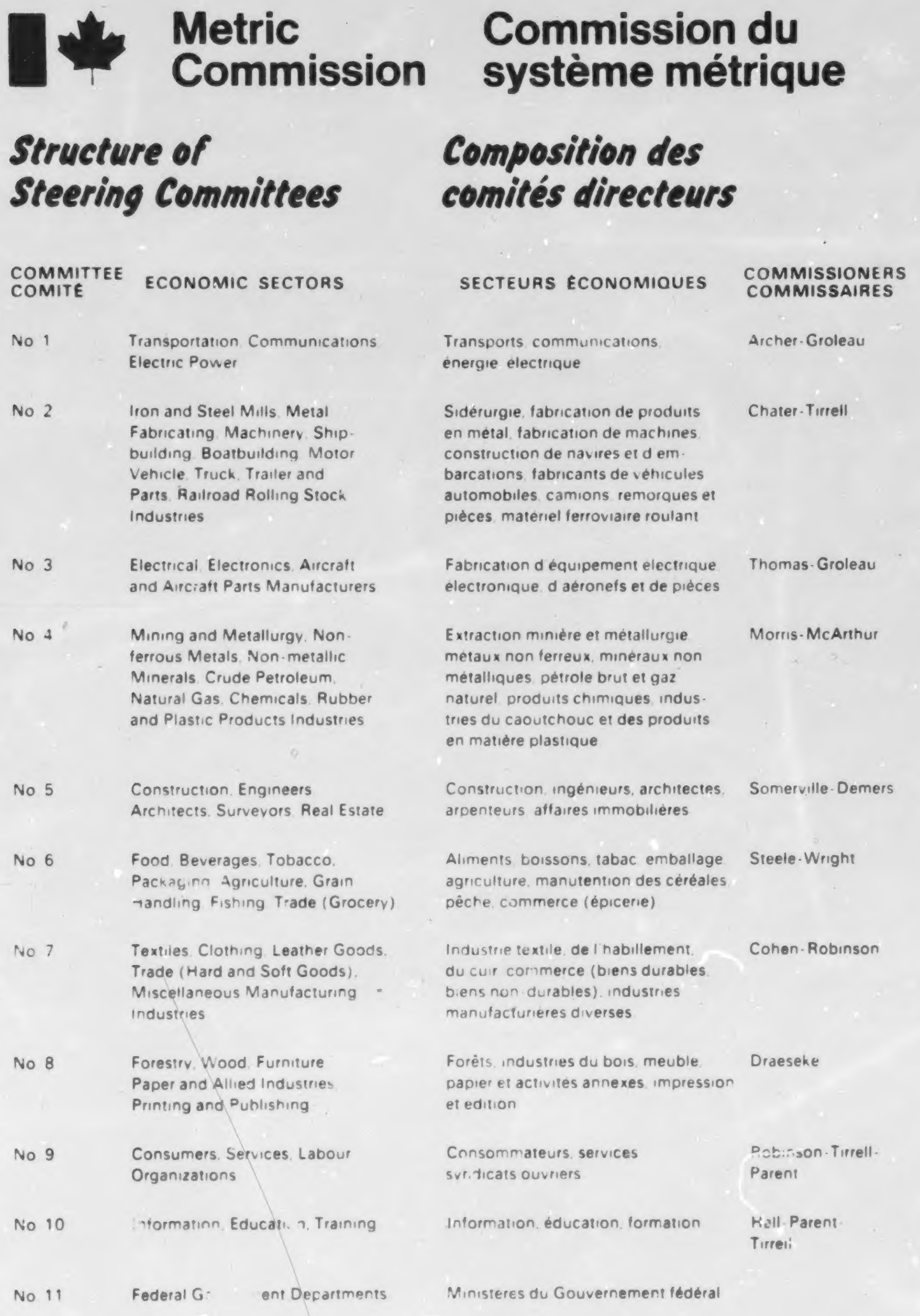
The continuing task of the Steering Committees and their respective Sector Committees is to monitor the progress of conversion and suggest any necessary modifications to plans in order to meet changing conditions.

The sector plans are guides for the individual firms and organizations concerned. While there is no obligation on any firm to conform to them, they represent the best judgment of the industry on how to go about the process of conversion.

Schedule

The White Paper did not set a deadline for the completion of conversion. The scheduling of metric conversion in Canada is obviously complicated by the fact that as yet the U. S. has not made a decision to convert, and the United States' market represents a major share of Canada's exports of manufactured goods.

Despite the uncertainty in the U. S. plans, Canada is nevertheless proceeding to develop tentative schedules. In September 1973 the Canadian Metric Commission outlined target dates for conversion. The four phases of investigation, planning, scheduling and implementation are all planned to be completed by the end of 1980 when, hopefully, the day-to-day transactions in the economy would be entirely metric. The investigation phase, now underway, should peak in activity early in 1974, while the planning and scheduling phases should extend through 1974-75 and be substantially complete in 1976.



Metric Commission — Commission du système métrique

Structure of Steering Committees — Composition des comités directeurs

COMMITTEE COMITÉ	ECONOMIC SECTORS	SECTEURS ÉCONOMIQUES	COMMISSIONERS COMMISSAIRES
No 1	Transportation, Communications, Electric Power	Transports, communications, énergie électrique	Archer-Groleau
No 2	Iron and Steel Mills, Metal Fabricating, Machinery, Shipbuilding, Boatbuilding, Motor Vehicle, Truck, Trailer and Parts, Railroad Rolling Stock Industries	Sidérurgie, fabrication de produits en métal, fabrication de machines, construction de navires et d'embarcations, fabricants de véhicules automobiles, camions, remorques et pièces, matériel ferroviaire roulant	Chater-Tirrell
No 3	Electrical, Electronics, Aircraft and Aircraft Parts Manufacturers	Fabrication d'équipement électrique, électronique, d'aéronefs et de pièces	Thomas-Groleau
No 4	Mining and Metallurgy, Non-ferrous Metals, Non-metallic Minerals, Crude Petroleum, Natural Gas, Chemicals, Rubber and Plastic Products Industries	Extraction minière et métallurgie, métaux non ferreux, minéraux non métalliques, pétrole brut et gaz naturel, produits chimiques, industries du caoutchouc et des produits en matière plastique	Morris-McArthur
No 5	Construction, Engineers, Architects, Surveyors, Real Estate	Construction, ingénieurs, architectes, arpenteurs, affaires immobilières	Somerville-Demers
No 6	Food, Beverages, Tobacco, Packaging, Agriculture, Grain Handling, Fishing, Trade (Grocery)	Aliments, boissons, tabac, emballage, agriculture, manutention des céréales, pêche, commerce (épicerie)	Steele-Wright
No 7	Textiles, Clothing, Leather Goods, Trade (Hard and Soft Goods), Miscellaneous Manufacturing Industries	Industrie textile, de l'habillement, du cuir, commerce (biens durables, biens non-durables), industries manufacturières diverses	Cohen-Robinson
No 8	Forestry, Wood, Furniture, Paper and Allied Industries, Printing and Publishing	Forêts, industries du bois, meuble, papier et activités annexes, impression et édition	Draeseke
No 9	Consumers, Services, Labour Organizations	Consommateurs, services, syndicats ouvriers	Robinson-Tirrell-Parent
No 10	Information, Education, Training	Information, éducation, formation	Hall-Parent-Tirrell
No 11	Federal Government Departments	Ministères du Gouvernement fédéral	

Figure 4. Steering Committees of the Canadian Metric Commission

According to this schedule, implementation should commence in 1975 and reach its peak in 1977-78, though some industries would no doubt continue operating with imperial units for a longer period (Bank of Montreal, 1974).

It was reported recently by Mr. Paul Boire, Executive Director of the Canadian Metric Commission, that the Metric Conversion Committee of the Road Transportation Association has proposed a plan, beginning in January 1974, for tentatively achieving essentially complete conversion of the highway systems in Canada by the end of 1979. It is hoped that the highway signs from coast to coast will be converted over a one-month period by 30 September 1977. In the area of meteorology, tentative plans have been made to give weather forecasts and reports in SI units starting April 1975. Temperatures will be provided in whole degrees Celsius after an interim period of no longer than six weeks of dual reports. In September of 1975, precipitation amounts for rain and snow are expected to be reported in SI (American National Metric Council, November 1973).

In Canada education is the responsibility of the individual provinces. There is no federal education department. While some school boards are in the process of converting to metric at certain grades, it is expected that the general emphasis on SI in the primary grades will commence in the fall of 1974.

General Approach

It is a bit early to attempt to characterize fully the metric conversion approach to be followed in Canada since the ground rules and strategy are still in the formative stage. Nevertheless, some features are beginning to emerge.

According to Boire (1973), the basis of the Canadian approach to metric conversion is that it is a voluntary process, with each firm and organization being guided by its appreciation of its short- and long-term interests. A corollary of this approach is that each unit of the economy is expected to identify the opportunities for change and to bear its own costs, just as it will reap the benefits arising from the change.

Fundamental concern for the consumer is reflected in the Consumer Packaging and Labeling Act directed at controling the information given to the consumer on the labels of all prepackaged goods. In 1973 there was dispute as to whether a producer of prepackaged goods may sell a product identified exclusively in metric measurement terms. The intent of the draft legislation was to protect the consumer during the changeover period by providing for both customary and metric measurements on prepackaged goods, and no provision had been made for the customary unit to eventually disappear. Accompanying this concern, however, was the fear that if dual labeling were allowed to persist indefinitely the consumer would ignore the metric measure, and the time required before thinking metric would be unnecessarily prolonged, as was learned in Britain. Accordingly, the Executive Director of the Metric Commission recommended that the Act be amended to allow labeling in metric units alone (Boire, 1973). Recently the Act has been rephrased to require dual labeling, except where the package is already a standard metric size or becomes so, in which case metric only labeling is legal (Metric Association, November 1973).

Publications providing guidance to producers and to consumers are already in evidence in Canada, despite the early stage of their conversion (Department of Consumer and Corporate Affairs, 1973a, 1973b: Metric Commission, 1973). An example of one of their "think metric" posters is provided as Figure 5.

Early in 1974 it is expected that the Metric Commission will announce a major public information and education program, in phase with the individual sector plans for commercial and industrial conversion. It is also expected that the Commission will begin publication of a newspaper covering progress of metric conversion (Metric Information Service, December 1973). An orientation to the metric system in general and its history and application to Canada specifically is provided by Allen (1973).

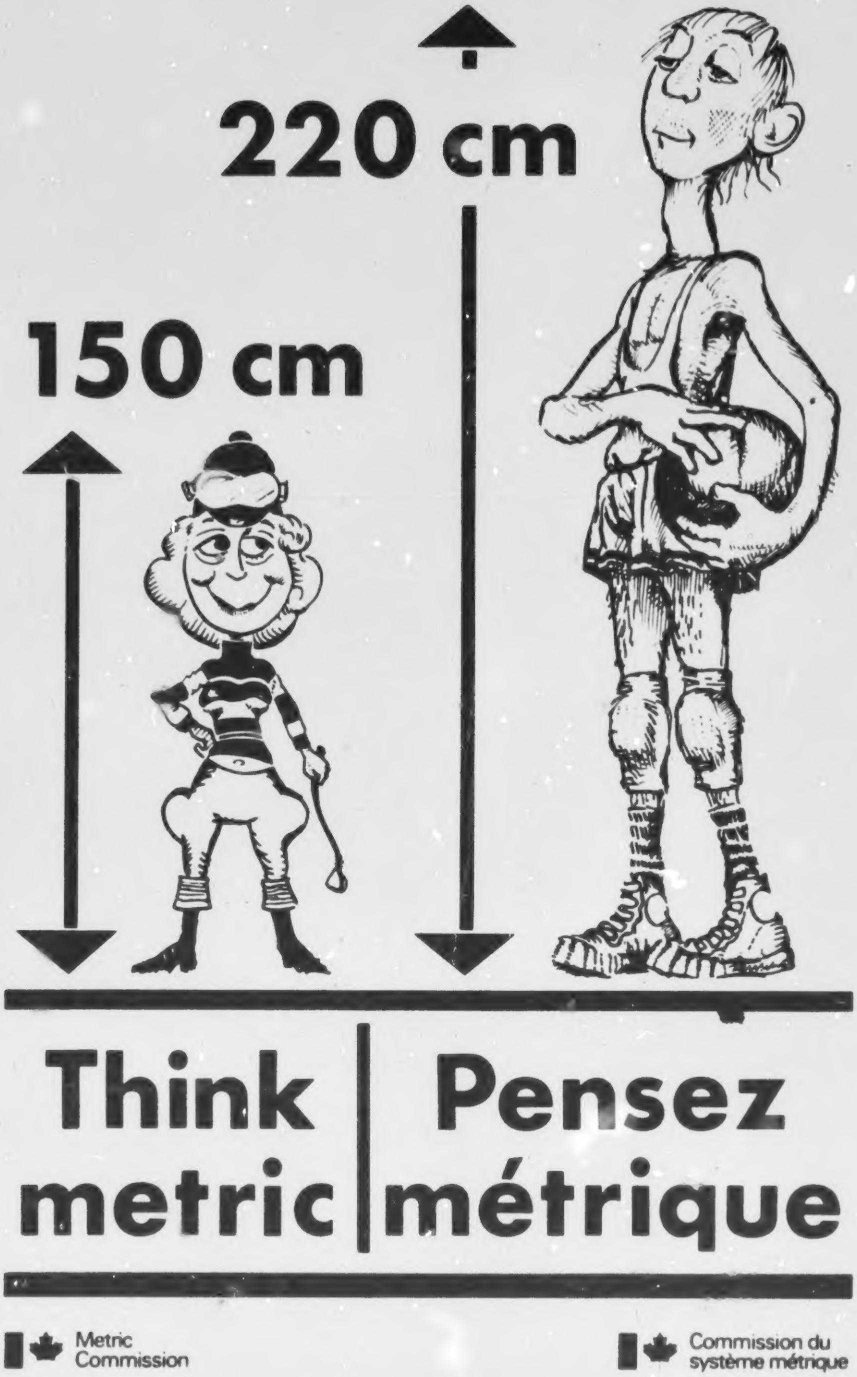

220 cm
150 cm
Think metric
Pensez métrique
Metric Commission
Commission du système métrique

Figure 5. Example of Canadian Poster to Encourage "Thinking Metric"

FINDINGS

The findings presented below reflect the results of an analysis of our total information resources, including questionnaire responses, published materials, working documents and correspondence. The information is organized according to issue and topic rather than by country. The major focus is on the contributions of the entire data pool to each issue and topic, not on a comparison of one country to another. Thus the reader will find that a number of items, based on several countries' experiences, may be grouped under one topic heading. The findings stress common experiences that appear to be confirmed across countries.

The major topics dealt with in this section are:

- Groups Exerting Positive Influence for Metrication
- Teacher Training
- Instructional Strategies
- Metric Instructional Materials
- Problems in Metric Education, and Some Solutions
- How Should Conversion Have Been Approached Differently?

Groups Exerting Positive Influence for Metrication

The Metrication Board itself has carried a major influence in Great Britain. The Royal Society and the Association for Science Education were two organizations whose early conferences and publications did much to stimulate and sustain interest in conversion. Professional associations of teachers have been steady supporters. Key activities of these "prometric" groups included organizing exhibitions, setting up advisory groups and planning committees, holding conferences, and publishing and disseminating information and teaching guides to facilitate conversion.

The industrial training boards also assumed a major role in providing information, training recommendations and instructional materials. Many of the major industries took the lead in developing their own programs for change. The British Standards Institution and the engineering industry were highly committed. Professional associations taking a prominent role were those representing engineers, mathematical sciences and the Association for Science Education.

The early emphasis on metrics in Great Britain's primary schools has been widely recognized. This commitment itself provided added momentum.

A major influence for the introduction of the metric system in Australia was the Senate Select Committee on the Metric System of Weights and Measures. Through it, the Metric Conversion Board was established. The Standards Association of Australia was another organization that played a major role through its establishing of metric standards. At the state level, it was typical for an inter-departmental committee to exert the lead in coordinating change among the various departments. Within each department, intra-departmental committees were usually established that were concerned with the program of conversion for that particular department.

The fact that the government has taken a lead role has apparently had a positive effect upon the country. This contrasts rather sharply with the English situation. There the government initially tended to remain aloof, with metric conversion having been decided upon and pushed by industrial groups primarily. Other groups that had a positive effect on Australia's metric conversion include the Chamber of Commerce, the State Education Departments, the Australian Broadcasting Company and other news media, and the publishers.

The Metrication Department of the South African Bureau of Standards was given high praise by our survey respondents for their leadership in planning and coordinating the changeover. Special mention was made of the guides and publications of the Department. The Department of National Education of the Republic of South Africa was also often identified as one of the organizations exerting a positive influence on metric conversion.

The groups in New Zealand most often mentioned as exerting a major influence for the introduction of the metric system in education were the Metric Advisory Board, the New Zealand Standards Institute and the Department of Education--the first for their overall direction of the changeover and the latter two for their specific directives.

Teacher Training

Strong needs for teacher training became apparent in the initial stages of metric conversion in education. In Great Britain these needs were responded to by both in-service training and by departments and colleges of education. A substantial share of in-service metric training was assumed by the British network of teacher centers. Teachers' centers throughout Great Britain offered numerous in-service courses. Such training included lectures, discussion groups, workshops and the production of reports and exhibitions. Courses ranged from one-session meetings to a several-week course. Typically, two two-day courses or workshops were held. The departments of education in the higher education system also offered both pre-service and in-service training.

A 1970 review by the National Union of Teachers of courses on metrication at teacher centers found a wide discrepancy in extent and content of early training. A representative sample of their findings is reproduced in Table 2 (National Union of Teachers, 1971).

Many of the teacher trainers in Great Britain trained themselves by programmed learning, often using materials they had acquired from industrial sources.

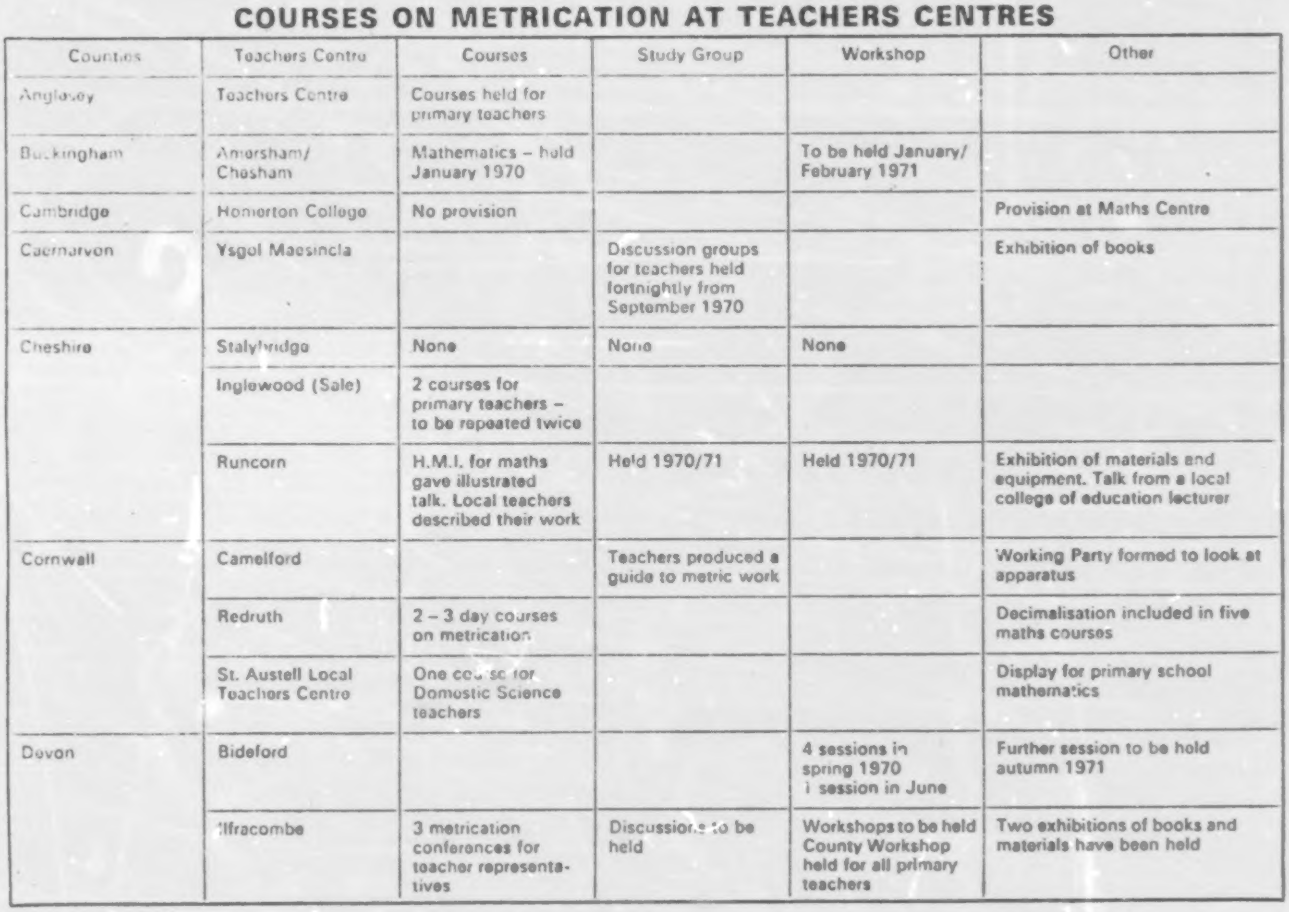
The responsibility for teacher training in Great Britain fell largely upon the local education authorities. A December 1970 survey of 200 LEA's revealed that 157 had arranged for special courses for teachers and 112 had published materials for use by teachers (Metrication Board, 1971).

The Metric Conversion Board in Australia was not responsible for any teacher training, as such. Rather, such training was the responsibility of the state departments of education. Of these, Queensland was reported as among the best organized. Here the use of advisory teachers and inspectors appeared to play a key role in teacher training. Their plans for metrication were formulated in three phases:

1. In-service training of teachers;
2. Distribution of metric equipment to schools to assist teachers in introducing metric units into their classes;

TABLE 2

Representative Example of British Teacher Training Courses in 1970*



COURSES ON METRICATION AT TEACHERS CENTRES

Counties	Teachers Centre	Courses	Study Group	Workshop	Other
Anglesey	Teachers Centre	Courses held for primary teachers			
Buckingham	Amersham/ Chesham	Mathematics – held January 1970		To be held January/ February 1971	
Cambridge	Homerton College	No provision			Provision at Maths Centre
Caernarvon	Ysgol Maesincla		Discussion groups for teachers held fortnightly from September 1970		Exhibition of books
Cheshire	Stalybridge	None	None	None	
	Inglewood (Sale)	2 courses for primary teachers – to be repeated twice			
	Runcorn	H.M.I. for maths gave illustrated talk. Local teachers described their work	Held 1970/71	Held 1970/71	Exhibition of materials and equipment. Talk from a local college of education lecturer
Cornwall	Camelford		Teachers produced a guide to metric work		Working Party formed to look at apparatus
	Redruth	2 – 3 day courses on metrication			Decimalisation included in five maths courses
	St. Austell Local Teachers Centre	One course for Domestic Science teachers			Display for primary school mathematics
Devon	Bideford			4 sessions in spring 1970 1 session in June	Further session to be held autumn 1971
	Ilfracombe	3 metrication conferences for teacher representatives	Discussions to be held	Workshops to be held County Workshop held for all primary teachers	Two exhibitions of books and materials have been held

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*From National Union of Teachers, 1971.

3. Issuing of additional textbooks which use metric units and the revision of existing syllabi to incorporate changes brought about by metrication.

Practical workshop sessions under the supervision of inspectors of schools and math advisory teachers proved especially effective. In these sessions teachers used materials from a metric kit developed by the Queensland Department of Education. This kit contained overhead transparencies, teacher activity cards, exercises using metric units, a Try Your Metric Knowledge booklet, and a range of metric equipment (tapes, rulers, trundle wheel, scales, etc.), along with a handbook of instructions (Research and Curriculum Branch, Department of Education, Queensland, 1972). Samples of children's activity cards were also included in the kit to assist the teacher in efforts to experiment with, and to progressively implement, the metrication program in the classroom. The kit was designed for use with a maximum of about eight teachers for a period of three and a half hours.

In addition to the metric kit, a curriculum paper entitled Introducing Metric Units into Primary Schools (Research and Curriculum Branch, Department of Education, Queensland, February 1973) was issued to each teacher. In this paper the strategies which could be useful in introducing the metric system were explained. The Department of Education also published a guidelines paper entitled Metrication and the Secondary Teacher (Research and Curriculum Branch, Department of Education, Queensland, May 1973).

Summer school sessions of one week's duration were held during 1972 and 1973. The active workshop approach appeared much more effective than lecture-type seminars. This approach helped teachers develop an increased interest in metrication, acquire practical knowledge of and ability to use metric units, and overcome any fears that may have developed through the lack of understanding of the nature of metrication and its implications for the teaching of mathematics. "Remember," says the Metric Conversion Board, "the greatest barrier to learning is fear of something new; overcome this fear and learning will be easier (Metric Conversion Board, no date, p. 11)."

The distribution of publications to teachers was a strategy used in other states as well. In-service training was also provided to teachers at both primary and secondary levels.

In South Africa the Bureau of Standards provided a variety of publications and circulars to each school. These formed the basis for discussions and study groups. Talks were also presented by members of the Inspectorate.

A typical program described by one college-level source in South Africa was as follows. "Our college has introduced metrication into education in four ways:

1. Three college lecturers attended two courses on the SI conducted by (a) the Metrication Department of the South African Bureau of Standards, and (b) the Department of National Education of the Republic of South Africa.
2. A one-day seminar in metrication was conducted for school teachers.
3. Lectures were given to sections of industry at the college and to individual concerns at their factories.
4. The SI is applied daily to all college teaching and administration. This has been a normal, effective effort by staff convinced of the ultimate benefits to be reaped by metrication."

The Central Institute of Technology (C.I.T.), Petone, New Zealand, is one of 12 technical institutes which implemented metrication programs at the request of the New Zealand Department of Education. The C.I.T. describes the sequence of steps taken to introduce metric conversion into the educational system as follows:

1. Appointment of a tutor as metric coordinator and a planning committee.
2. At the request of the Department of Education the C.I.T. conducted a two-day course on SI Units for tutors from the other institutes.
3. Courses for tutors within the institute; "on the spot" solutions to problems.

4. Publication of a metrication bulletin for C.I.T. tutors.

5. Conducting courses for industry and representatives from government departments and local bodies.

6. Limited assistance to teachers from local secondary schools.

7. Material and advice where requested.

The Department of Education published amended mathematics books and additional card sets. Conversion tables and exercises were deliberately excluded. The Department also is publicizing the introduction of new measures as they come into use over a period of ten years, with background of origins, etc.

It seemed to be the consensus in New Zealand that most teachers cope successfully with a change when the need exists.

Specific problems encountered in teacher training are discussed in a later section.

Instructional Strategies

Primary and Secondary Education

An important aspect of learning the metric system is learning the rational relationships among metric units. For example, how a cubic decimetre can be built up and shown to be equivalent to a thousand centimetre cubes. The relationship of the units of volume, area, capacity, and mass to the metre is not usually apparent to students, or to most teachers. Training workshops in Britain showed how to demonstrate these connections with simple materials. The teaching of numerical relations based on cuisenaire-type cubes and rods provided an easy transition to the metric system.

A major concern in metric instruction is teaching the concept of mass rather than weight. Children accustomed to journeys to the moon appear to grasp the distinction readily. Teaching strategies to make this distinction clear were developed in Britain; however, most teachers decided to postpone the issue until older children raised questions.

A strategy repeatedly emphasized in Britain, both in industry and education, was to keep conversion training and techniques at a minimum. Familiarity with approximate equivalents, e.g., 4 inches is about 10 cm, is considered sufficient. The use of conversion tables and mechanical or electrical conversion devices will fill most needs. It is felt that conversion exercises confuse the student, maintain the imperial system as the basic unit, and create a false complexity with respect to SI.

Training in direct visual and physical estimation of the metric measures of common objects was generally lauded as useful facilitation of "thinking metric." School organizations reported success across grade levels, including staff, with initial sessions of measuring one's own body dimensions and mass in metric.

In all levels of education in South Africa, the direct and practical approach to SI with no reference to imperial units was also found to be most effective, e.g., comparison of metric units to known objects--the length of a table, the mass of a book, etc.

In December 1973 Great Britain sponsored a metrication quiz with participating junior schools. The winning team received tne awards and presentation by Lord Orr-Ewing, Chairman of the Metrication Board. The school's headmaster, Mr. John Wood, said the staff had considered having a metrication quiz competition with the children, but "we chickened out because we knew we would be humiliatingly trounced. Our children think metric, but we still have to convert (Luton Evening Post, 10 November 1973)."

Australia anticipated that the primary school would be a key factor in its metrication program. Whereas the child's home environment reflects only partially that a new system of measurement is being introduced, his school experiences are aimed at making him fully conversant with this new system. Children are expected to help their parents adjust to the change with the hope that this will result in greater familiarity with, and acceptance of, the metric system among the general public. It was assumed that children would not have particular difficulty in learning metric units, but in unlearning imperial units. This problem was obviated by giving the child a wide range of practical experiences involving only metric units. It was recognized that if both units are allowed to coexist, as they were in Great Britain, unlearning becomes extremely difficult, and conversion from one unit to the other becomes a common but undesirable practice (Research and Curriculum Branch, Department of Education, Queensland, February 1973).

The changeover to metric measurement in Australian education is well in advance of the changeover in the community at large. In order to insure a positive approach in education, the formal teaching of measurement in imperial units was discontinued in primary schools early in 1972. The gradual introduction of metric measurement into community living has served to reinforce school learning. It was pointed out in our survey that for very young children it was important that weights and measures learned at school relate directly to their experiences out of school.

Activity lessons which involve the student in practical measuring situations have proved effective for both children and adults. In one state adult education center the class was divided into small groups which worked on various practical exercises at their own rate while the teacher moved from group to group.

One suggestion offered to allay fears of measuring in new units is to simply have students measure any common object in both units and notice that they do exactly the same thing. Another approach is to hold out some convenient object, such as a pocket handkerchief, and ask, "Taking this as the unit of measurement, how long is a horse?" Answers vary widely. Then the demonstrator marks off the most common guess along a wall against which they have a fairly clear notion of how big a horse would be. The answers are typically wildly off. This demonstrates how the process of judgement in measurement is independent of the units being used and that what people will actually be doing will not change, even though the language they use will change.

In Great Britain this approach was advocated by the Department of Education and Science, as exemplified in the following quote from the Staff Inspector for Mathematics:

> In the large majority of primary schools a sound understanding of measurement is gained through first hand experiences, often by the age of 7. Teachers have found that many preliminary experiences are necessary before children are ready to appreciate the need for standard units of measurement . . . Varied activities in measurement, first with arbitrary units (of the children's own choosing) and later with a wide range of standard units, appropriate to the work in hand, ensure an understanding not only of measurement of all types, but also of the fact that measurement can never be more than an approximation (Biggs, 1970, p. 235).

Home Economics Education

The Association of Home Economists originally set up working committees which included representation from women's groups, institutional management associations, and observers from agriculture and the Department of Education. The importance of in-service training for teachers was stressed. However, the schedule of conversion in Great Britain emphasizing industry first, rather than retail trade, delayed the effect on the consumer.

The Association worked to establish small advisory committees, experimental training groups, area meetings in teachers' centers, conferences, and in-service workshops and courses.

Australian respondents stressed the importance for students in cooking to appreciate the relationship between metric measures and such existing measures as spoons, cups and ounces. Standardized metric measuring cups and spoons are now available in Australia. With the introduction of temperature in metric, students need to relate such terms as "cool," "warm," "moderate," "hot," "slow," and "fast" to various Celsius temperatures.

In nutrition, food tables had to be adjusted to use the kilojoule rather than the kilocalorie (commonly called the calorie). One kilocalorie is approximately 4.2 kilojoules. In consumer education it was emphasized that students must develop an appreciation of the relationships among cost. size and mass. They also need to gain familiarity with metric sizes for furniture, kitchen fittings, containers, cooking utensils and other household materials.

Vocational Education

Some of the most far-reaching changes have occurred in the area of industrial education affecting the sizing of lumber, nails, screws, nuts, drills, taps and dies, as well as the units expressing the speed of various machines and the dimensions of drawings. This did not require that all existing tools and machinery need to be replaced, however. Most hand tools and many standard machine tools may be used regardless of the measuring units.

From the Research and Curriculum Branch of the Department of Education in Queensland, Australia come the following interim measures that might assist teachers and students during the conversion period (1973, p. 14):

- "Simple metric scales may be constructed and attached to instruments to replace imperial scales;
- Metric size tools may be marked in some distinctive way to distinguish them from other tools;

- A set of drills approximating metric sizes may be made up from existing number, letter and inch-dimensioned drills.'

As an experiment, in Western Australian technical colleges all imperial measuring devices were removed from some metalworking classrooms and replaced by metric devices. With no special instruction in the use of the metric devices, the students achieved the same rate of success as they had with imperial unit devices. A similar experiment was conducted in woodworking classes with about the same results.

In technical education it was found that many major items may be built or converted by the students themselves, providing a worthwhile learning experience in addition to assisting in equipment modification.

Agricultural Education

One of the persistent areas of concern is how to educate and, in turn, motivate specialized groups. Along this line, it is interesting to note the experiences of Tasmania, which has conducted seminars to train people providing services to farmers, such as extension officers and suppliers of goods and machinery. Among possible problems identified at the conferences were ignorance and apathy of some farmers, increase in spare parts and tools, and fear that conversion could contribute to inflation. It was suggested that a clear shutoff point be established, at which time imperial units would no longer be used. Participants suggested that the Department of Agriculture should promote farmer discussion groups, use the metric system only, and encourage farmers to "think metric." It was recommended that the Metric Conversion Board consider the use of television and encourage use of metric units in advertising.

The results of the seminars seem to indicate that the problems for farmers were little different from those faced by other sectors. It was felt that extension officers and others in advisory capacity should talk metric to farmers and have aids to demonstrate conversions wherever necessary. Charts to cover working ranges of farm machinery should be readily available (MCB Newsletter, October 1973).

Based on the results of a seminar conducted in 1973 by the West Australian Department of Agriculture, it was concluded that changes will continue to take place in the rural sector with virtually no disruption (MCB Newsletter, May 1973). The belief was emphasized that the key to smooth conversion for the farmer is guidance by extension officers, commercial representatives, and the "man behind the counter." This explains why the Board is concentrating its efforts not upon the farmer but upon those who serve the farmer. It was further concluded that the Department of Agriculture has the main role in the metric education of farmers, but that this role would be a casual one in the sense that metric terms would be used and explained in day-to-day extension activities, while group extension work on metrication would be provided if requested by farmers.

Industrial Training

In Great Britain the Industrial Training Boards of various industries assumed the initiative and developed a variety of instructional strategies and materials. An approach used by the Petroleum Industry Training Board is summarized in Table 3. Courses in a variety of measurement applications were developed by polytechnic and technical colleges (Metric Information Service, September 1973).

Strategies for industrial training commonly reported in Great Britain include:

1. Teaching people only what they need to know to do their job.
2. Commencing training immediately before the on-job applications of metric are to start.

Training failures and negative attitudes by trainees were reported where training became complicated beyond immediate job requirements or when lags between training and application occurred. The need for a "pre-training" phase of fostering awareness of the metric system and awareness of the need and importance of metrication was emphasized by both educational and industrial training organizations in Great Britain.

TABLE 3

An Example of the Training Approach used in British Industry
(Petroleum Board, 1972, p. 19)

SUMMARY

AWARENESS TRAINING -	is the essential preliminary to job training. See Part II for details.
THE JOB TRAINING PLAN -	WHAT must be learnt? Extract this information from the company operation plan. WHO needs training? Identify individual training needs. Then combine these into groups with similar needs based on subject matter, categories of staff, depth of knowledge needed. WHEN should the training be given? Get the approximate dates from the operational plan. Relate these to starting level, additional training needed, and method of training, to arrive at the exact starting dates for each group. HOW should the training be done? Decide which method or combination of methods is best suited to each group's requirements. Prepare the training material.
THE TRAINING PROGRAMME -	Prepare a CONSOLIDATED TABLE a BLOCK PROGRAMME and DETAILED PROGRAMMES
TRAIN INSTRUCTORS -	both in subject matters and, most important, in instructional technique.
VALIDATE THE TRAINING -	find out how well it worked and correct any weakness.

It is expected that professionals and subprofessionals in Australian industry will be adequately provided for by professional institutes. A training brochure was prepared for small firms and training officers of large firms, by the Industrial Training Sector Committee of the Metric Conversion Board (1971). For skilled and semi-skilled personnel, on-site training of three to four hours immediately prior to working on metric projects is expected to be sufficient. The training will most likely be provided by the organization training officer with guidance from the Government pamphlets and supplemented by locally produced models and visual aids. It is considered that teaching of length, area, volume and mass measurements in metric units will be sufficient in most cases. Retraining of personnel at nearly all levels of industry and commerce will be needed to make them familiar with new metric units that they will be required to use.

According to the Metric Conversion Board, the general experience of firms that have been through metric conversion in both U. K. and South Africa is that problems which appeared formidable when viewed as a whole were easily solved when taken one-by-one. One of the major problems is coordination among various sectors in society. In building, for example, there must be coordination between industries supplying materials and components, the designers and the regulatory bodies. The Board encourages that training be coordinated with industrial and general conversion programs for the following reasons:

- "Personnel will forget much of what they have been taught if the application of knowledge is delayed too long.
- Staff movements could result in unnecessary retraining if training is given too soon.
- The Metric Conversion Board envisages that the general public will be exposed to a wide range of publications and publicity and too early training could lead to unnecessary duplication.
- Appropriate data sheets, standard publications, trade literature and commercial conversion aids will become available as metric conversion proceeds. These could reduce or eliminate the need for some training.

- Personnel who face metric conversion late in the program should not need as much training as those who are first to change.
- The experience gained in private life by many people could reduce or eliminate the need for some training (Metric Conversion Board, 1971a, p. 9)."

One of the major policies recommended to industries is that personnel should not be taught any more than they need to know to do their jobs with the necessary degree of understanding. As a start toward a more detailed examination of training needs, it was suggested that the work force be divided into appropriate categories. The following starting points have been suggested by the Australian Metric Conversion Board for determining categories of staff for training purposes:

- Personnel requiring a full working knowledge of calculations, e.g., engineers, should be able to handle conversion easily and should need only minimal instruction.
- Personnel requiring a working knowledge of simple calculations, e.g., supervisors, technicians, inspectors, etc., may require some specific training and will gain proficiency through on-the-job training.
- Personnel requiring simple basic knowledge for reference purposes, such as invoicing clerks, shorthand typists, etc., should not be overlooked and at least should receive instruction in the meaning and correct use of those metric terms likely to be encountered in their normal activities.

There may also be a requirement for specific training programs for key personnel, for example supervisors, who will in turn train other members of the work force. It was assumed by the Board that the most effective way to carry out much of the training will be as on-the-job training organized by local management. Two approaches were suggested for consideration by the Board

1. "The selection of pilot projects for execution in metric units so that early experience could be gained in metric conversion. Probably the first practical pilot projects would be work internal

to individual organizations. Following this experience, those engaged in implementing such changes should be encouraged to publish their experiences in appropriate journals to inform others confronted with similar exercises.

2. Increasing awareness of the change to metric by attaching signs illustrating various metric units on objects in the worker's environment. Such things as length, mass, volume, etc. should be able to be illustrated with novelty introduced into the displays. Journals and house magazines could foster interest by reporting on novel displays (Metric Conversion Board, 1971a, p. 13)."

The purpose of these efforts would be to assist personnel to think metric and to help them gain self-confidence in dealing with the new units. It was cautioned that the displays should not be set too far ahead of conversion programs, possibly about three months before the change is introduced.

In a number of Australian establishments where a significant amount of metric work has already taken place no great problems have been confronted, despite the prediction that such problems would occur.

One establishment found that the changeover on a major project did result in some loss of efficiency for a period of six to eight months. This was apparently brought about by the loss of ability to think intuitively when working with unfamiliar units. The problem apparently was not a major one and it was concluded that in the present conversion program personnel will have the experience of metric conversion in their private activities to assist them in adapting to the change

In summary, two main points were emphasized by the Board. First, the need for coordination, and second the caution against over-training. It was felt that there may possibly be a strong inclination in some areas to overtrain and the principle should be observed that personnel should not be taught any more than they need to know to do their jobs with the necessary degree of understanding. And finally, such training should be given immediately before knowledge is to be applied in order that the costs and effort involved in training for metric conversion be most efficiently applied.

Metric Instructional Materials

Industrial training boards in Britain displayed early concern with materials development. These materials reflect systematic, instructional development techniques, including prototype testing and revision. Typically they include procedures to determine the metric information needs of various job categories. Such efforts appear to have been well underway by 1967-68. Simultaneously, some school associations were meeting with publishers to establish the need for bringing textbooks up to date.

Later reports from Great Britain frequently mention the effectiveness of programmed instructional materials--most of which were initially developed for industry. Industrial training has also emphasized audiovisual materials, especially films and slide/tape kits.

A number of clearly written teacher guides were produced and widely disseminated in Great Britain. In vocational education the Schools Council's booklet Measure for Measure: A Guide to Metrication for Workshop Crafts and Technical Studies (Schools Council, 1970) and the Kent County Council guide SI in Handicraft and Technical Drawing (Kent County Council, 1973) are useful examples. For teachers in Britain's primary schools, the booklet Metres, Litres and Grams (Schools Council, 1971) was widely distributed. A film showing how primary teachers could introduce the concepts of metric measurements to children was produced by Hull University and distributed by the Metrication Board.

Considerable emphasis in Great Britain has been placed on the development of simple "teacher-made" materials, particularly for the primary schools. From the information received from Australia the schools in Queensland have had particular success using a metric kit for teacher training as described previously under "Teacher Training."

Another kit, this one called Metrikit, was designed by the Adult Education Sector Committee of the Metric Conversion Board and distributed in mid-1973. This kit was primarily intended for use in formal education through adult education departments or divisions in each state. However, the kit may also serve for initial familiarization with metric units by community groups. It comprises conceptual aids, slides, speaker's notes (lecture outlines) and background data to enable the speaker to answer 'off-beat, awkward questions." Display data are also included and provision is made for audience involvement by the inclusion of personal statistics cards and a self-assessment quiz. This kit is available for loan to appropriate groups through outlets in each state.

The Metrikit is also being used at parent meetings in response to requests on the part of parents to explain the rudiments of SI so they in turn can assist their children.

Allen (1973, p. 10) makes the following specific suggestions to teachers in Canada:

> All learning aids should stress the decimal nature of the system. Avoid metre sticks divided into *fourths* and litres into *halves*, *fourths*, and *eighths* (such *are* being marketed). Keep aids simple. A rule subdivided beyond *centimetres* has no place in a Grade I learning situation. Stress, where feasible, aids which the children make themselves. Sealed containers of sand, suitably labelled, can become a set of metric masses. . . . Reject anything which has wrong symbolism. Rulers in particular should be carefully checked.

Together with his Mathematics Education class at Nova Scotia Teachers College, Allen has provided an innovative handbook for the construction of "critters" as an aid in developing metric concepts in teachers and students (Nova Critters, 1972-73). These "critters" can easily be formed out of linking centimetre cubes, which are currently being merchandized in both Canada and the U. S.

Problems in Metric Education, and Some Solutions

An attempt is made in this section to highlight those educational problems shared by the countries studied. The reader should be alerted that within any given problem area the experiences of more than one country will be presented for purposes of illustration. The major problem areas thus identified include:

- Resistance to Change
- Teaching Materials and Textbooks
- Equipment Conversion
- Teacher Training
- Vocational and Adult Education
- Communication and Coordination
- Lack of Firm Direction
- Special Problems in the Instruction and Use of the Metric System
- Breadth of Impact

Following this review of major problems, the next section summarizes how overseas respondents would now approach metrication differently, if they were to begin over again.

Resistance to Change

In Great Britain resistance from smaller businesses and industries was frequent. Industrial training boards also reported resistance from consumer groups and occasionally from firms within their area. Some individuals resisted the changeover, primarily from fear of their being too old to change. In addition, trainees often had negative expectations that learning the new system would be too difficult. Most industrial training sources emphasized the need to identify and overcome such human problems in the early stages of conversion.

Educational associations reported resistance from the non-science areas of education. However, more resistance was noted with regard to the replacement of familiar units than to metric education in general, e.g., dropping the angstrom, the dyne, the erg and the calorie. In some areas, the opposition of the anti-decimal group was felt. Unfortunately, in Great Britain the introduction of SI was also made at the time of another major revision in syllabi and examinations. This compounded initial difficulties.

Some resistance was felt from older housewives and elderly people. There were occasionally adverse articles in the press and one anti-metric interpretation on a national television program.

The close consultation with teachers, local education agencies and professional associations was a major influence in overcoming resistance. The Association of Home Economists also wrote to all publishers whose materials showed errors or emphasized straight conversion techniques.

Industrial training boards reported two major mistakes that caused resistance throughout industry: (1) not seeing a conversion problem because "they had already been working in metric," or (2) over-emphasizing the extent of the problem. Industrial training frequently stressed using SI as a public relations exercise, pointing up the easiness of the system. Emphasis on learning only what the particular job category needs to know and scheduling training immediately before practical applications were major coping strategies developed by industry. Careful advance planning, keeping all personnel adequately informed, and reassuring them that they are going to be helped to learn were also reported as strategies which minimized industrial resistance.

School associations also reported resistance due to inertia and the reluctance of individual teachers to give up traditional ways. There was additional anxiety on the part of many technical teachers that existing machinery demanded continued knowledge of traditional units, thus requiring dual measurement for an indefinite period.

In Australia there seems to have been little in the way of organized resistance to metric education. There have, of course, been many individual teachers who complained bitterly about the need to convert--particularly the older ones. Resistance to the overall conversion program has been rather light and spasmodic. Public criticism has been voiced because of alleged "unjustified" price increases coincident with metric conversion, and there was some initial opposition from certain state government departments because of the cost of conversion or the shortages of manpower. But on the whole, the general attitude seems best summed up by one respondent who indicates "Now we are stuck with it let us knuckle down and learn the new system." One state education department indicated that it was able to anticipate likely resistance and provide help to schools in meeting such difficulties through the following steps:

- Planning metric conversion implementation only after due notice;
- Consultation with suppliers of textbooks, reference books and teaching aids;
- Providing policy statements to allow teachers to plan for the change;
- Provision of teaching and learning aids free of charge to schools;
- Provision of skilled technicians to modify and adapt lathes and similar school equipment;
- Offering in-service education programs for teachers.

An adult education center indicated that when resistance was shown in the courses the standard approach was to show how easy the metric system is. Other arguments used were: "because it is faster, fewer fractions, reduced mechanical arithmetic, improved accuracy, relates to money, benefits international trade, simple relationships."

No organized resistance to changeover has been reported from South Africa. Minor resistance came from persons over 40 years of age, who had never had contact with any metric system of measurement. One respondent stated it this way: "We did encounter the type of resistance to change typical of conservatives. It solved itself in the course of time. Resistance to change is characteristic of an individual, not necessarily connected with metrication."

New Zealand has also been free of organized resistance to metrication. However our survey did indicate "a good many differences of opinion on timing and methods during the changeover."

Teaching Materials and Textbook Problems

Early materials needs in the schools were focused in primary education. Industry-developed materials were not suitable. The initial lack of appropriate "awareness" posters and other informational materials was vexing to the primary schools, which had been advised to start and complete metric changeover at an early date. As a result, teachers were confronted with the problem of developing their own materials. In Great Britain, the offices of the teacher centers played a major role in assisting teachers in constructing and calibrating simple measuring materials.

In a short time, increasing waves of materials became available to the schools from the industrial training boards, the Metrication Board and from commercial sources. Unfortunately, this avalanche of materials was not restricted by the imposition of standards, educational safeguard principles, or programs for materials evaluation. Many items were later found to be inaccurate, inappropriate, in error, or constructed from poor materials. The lack of early quality control has been a major complaint from educational groups in Great Britain. After the initial havoc had been wreaked, a small committee established through the Metrication Board and the British Standard Institution was organized to make recommendations for appropriate standards in measuring equipment. This committee included both teachers and manufacture

In the early stages especially, a notable problem in Australia was the lack of adequate textbooks and teaching materials with correct usage of SI. This problem persisted at least up until the middle of 1973, with relatively little material suitable for teaching the metric program available for use in primary schools.

According to the Department of Education in New South Wales, revisions of textbooks were appearing which did not fulfill the requirements of the syllabus committees or of the Metric Conversion Board. The primary textbook reviewing committee considered it essential to advise teachers that some publications were not using the SI; that terms, spelling and abbreviation were incorrect in some instances, and that inappropriate conversion operations were often stressed.

New Zealand's approach to the problem of metric textbook and material shortage was as follows:

- Publishers were given early warning of the problem.
- The Department of Education published new metric books or supplements to amend relatively new books.
- Grants were provided to schools by the Department to enable them to progressively replace non-metric books.
- New equipment was designed by the Department of Education and issued to schools.
- Some new equipment was purchased from overseas suppliers.
- Conversion kits, for instance, for lathes, were purchased from manufacturers.

The Central Institute of Technology reported a specific example, that of the specialized area of heating and ventilating, where good U. S. textbooks used the imperial system of units, as is customary in the engineering field. Lack of funds did not seem to be a major problem as the Department of Education provided generally adequate amounts for textbooks, equipment and training.

Some local education agencies in Great Britain reported problems because they had just purchased new books (non-metric) and thus were forced to request special funds for metric materials. Many schools needed extra financial help for replacing equipment and re-equiping craft rooms. Initial shortages of metric textbooks, as well as apparatus, and correctly calibrated machine tools were reported by many British school districts.

Many New Zealand organizations prepared materials for their own use (training booklets, primarily). These materials were checked by the Secretariat of the Metric Advisory Board. These checks have resulted in the rectification of many errors in the use of the metric system and in suggestions for the improvement of the material.

Materials from commercial enterprises in the form of children's games, conversion charts, booklets, slide charts, etc., were received by the New South Wales Education Department for review prior to their distribution to schools. The majority of the material was considered inappropriate because of faulty use of SI, lack of relevance to the learning of measurement, or stress placed on conversion.

Interestingly enough, the problem was apparently even more acute in the social science area such as geography where textbooks have a long shelf life. One question raised was: "How important is the availability of metric information in some of these subjects?" For example, is it important that children learn the exact heights of mountains in metres or is the relative height the important thing? This latter approach, of course, makes the provision of specifically metric texts and materials less important. The position of the Australian Geography Teachers' Association, on the other hand, was that metrication should be introduced as rapidly as possible, particularly in the field of cartography, and that it should be a total conversion, i.e., scales, grids, linear measurements, etc. Some problems are still present in the area of textbooks where commercial writers have improperly interpreted the suggestions of the Metric Conversion Board for the writing of metric notation.

The process of decision-making, however, can bog down in details and present barriers to the achievement of economies through standardization. For example, in Australia seven different education authorities turned out to be interested in about twelve different kinds of rulers. Questions arose, such as: What do you use rulers for and in what context? Do they need to be bigger than the paper you're using because you're ruling margins on it? Problems also arose in the coordination of decisions on paper sizes.

The textbook problem was also frequently mentioned in South Africa. Educators here had been depending upon the availability of "metricated" British textbooks but, due to a lag in conversion in Great Britain, these textbooks were not available at the time they were needed in South Africa. A partial solution to this problem was the preparation of supplementary leaflets for use by teachers with existing "non-metricated" texts. The teachers themselves frequently had to convert units for classroom teaching. Overall, little time was lost since it takes longer to teach the imperial system than the metric system, according to our South African respondents.

Similar problems were encountered in the secondary levels, especially in regard to available textbooks. It was shown by experience that it is undesirable to change over in a subject such as arithmetic before textbooks have been metricated. In these circumstances, an undue burden was put on both the teacher and student. Needless confusion arose when the student was taught SI in the classroom while using a non-metric textbook.

Once again, on the university and college level, lack of textbooks caused a certain amount of inconvenience. The lecturers themselves did the conversions and learned the SI in the process. The students, having already had exposure over the years to the "metric system," had no particular difficulty learning the few new units in SI. As new textbooks using SI were published, the old imperial ones were phased out.

There were special problems regarding materials for younger children. The gram is too small and the kilogram too large for most class weighing. There is a need for a one gram mass which little fingers can pick up. The usual centimetre/millimetre graph paper is too fine for primary grades. A two centimetre, by two millimetre has been found suitable (Williams, 1973).

Frequently, the metre is also found to be so large and the centimetre so small that a child cannot use it effectively. Children do need to know the elegance and simplicity of the metric system, however. This can be done irrespective of the standard. The sub-units and multiple units are selected for the purpose. British teachers found it particularly important to show the relationships between area, volume, and length.

Equipment Conversion Problems

Conversion of vocational education equipment presented special problems. The replacement costs of tools and machinery are high. In the British program there was typically no provision for government funds to support local school conversion. The changeover costs had to be absorbed by the local educational agency. Grant applications or levies were required. Although such conversion costs are formidable, schools did materially reduce them by a careful assessment of the timing required, of the degree of accuracy needed, and of the replacement schedule of existing equipment.

In a typical school room a number of equipment conversion tasks are relatively simple and may be done by the students themselves. Some tasks accomplished by children in a one-teacher school in Australia were:

- "Markings on rulers were masked with adhesive plastic which was then graduated in centimetres.
- Metre measuring sticks were made from dowel rod.
- The back of the school tape measure (one chain long) was marked off in metres.
- The graduations on the rain gauge were covered and then the gauge was re-graduated in milimetres.
- Plastic measuring jugs were calibrated using a medicine glass to measure in multiples of 50 ml.
- Tins previously graduated in pints, quarts and gallons were repainted and marked in litres and parts of a litre.
- The dial of a kitchen scale was covered by a dial, made by one of the children, which was then graduated in kilograms and grams.
- A set of masses was made using small bags of sand.
- The school's playshop was inspected and all articles marked in imperial units only were discarded. Where an article had both imperial and metric units, the imperial units were covered.

- A Celsius scale was affixed to the side of the school thermometer so that temperatures could be read in degrees Celsius (Research and Curriculum Branch, Department of Education, Queensland, February 1973, pp. 11-12)."

With more expensive equipment, there remains the problem of deciding what equipment to modify and what to replace. Conversion has to be phased within funding limits. In craft subjects, six years were often needed by many British institutions before complete metrication was accomplished.

Difficulties in Teacher Training

Almost all school staff required special training in SI. Frequently the overseas teacher in math, science and vocational education found that he or she knew a smattering of metric information--some of which was no longer appropriate under the SI system. Relearning was required. However, in Great Britain it was found that most science, math and industrial arts staff were capable of learning the system on their own. Other staff needed brief, but intensive, training workshops. This training was often conducted by science and math teaching staff.

One necessary component of teacher training, and this applies to both training in industry and in schools, is an initial awareness stage. This stage focuses on informing about metrication, its purposes and need, and its impact upon the activities of the target audience. Most teachers required reassurance that this change would not be too difficult or threatening to them personally, and that adequate training and support would be provided. Our results from Australia indicate that their smooth changeover to metric can be attributed in part to an advisory teachers' service and the in-service role played by the educational inspectors.

Conversion often presents some new demands on teacher training. In the adult education area courses were offered both for the general public in Australia, as well as for special groups such as the small businessmen, real estate salesmen, timberworkers, etc. In some areas it has been difficult to find teachers who are willing to teach the metric system to adults. In the early stages there was also some problem of lack of public interest. In 1972, for example, several courses for the general public that were planned in Tasmania had to be cancelled because of lack of support.

One of the problems faced by most instructors as they learned the SI units was the absence of an intuitive "feel" for the correct dimensions. This lack of a "sixth sense" for metric units was obvious in both student behavior as well as on the part of staff. Vocational education instructors reported that although they could instantly detect errors in the selection of materials and in machine settings under the English system, this ready visualization had to be painfully relearned for the metric system.

Vocational and Adult Education Problems

The remoteness of some industrial groups from access to higher education institutions and the difficulties of very small firms in providing training were early problems. A further problem was to communicate information regarding the proper units soon enough so that purchasing departments would not buy equipment which is "metric" but not SI. In Britain, the development of programmed and other self-learning materials was one solution. Training selected company staff to become within-company trainers was another. A general approach, reported throughout industrial training, was to treat the changeover as a thoroughly painless exercise and not to over-dramatize the difficulties.

In adult education the following problems were cited:

- Public indifference, particularly during the early years,
- Difficulty in finding teachers willing to handle adult education classes,
- Lack of funds to enable adequate support of adult education.

Another problem reported was that teachers were worried about advanced preparations during the early years of metric conversion. A considerable amount of background administrative work had been done, but the teachers felt that they might be burdened suddenly with problems of securing materials.

Two types of fears that most people have about metrication were repeatedly identified. One, they won't know what they are doing; and two, the fear that they will be alone in an uncharted jungle of conversion. According to our survey findings, the first fear can be overcome by rather simple exercises, while the second fear can be reduced by a firm government commitment with implementation on a broad front so that people can see metric conversion everywhere, not just in their own area.

Instructors of adults in Great Britain often found they were confronting two learning problems: (1) learning to use metric units, and (2) learning to use decimal arithmetic. Many workers and adults had never mastered decimals. Separate units of instruction, decimal and metric, were employed as this confounding became apparent.

One of the courses that is most affected by metric conversion is that of home economics. Cooking is complicated by the interaction of several variables, i.e., mass, volume, temperature, energy, time; all of which, with the exception of time, will be changing with metric conversion. In Western Australia, an experiment was conducted in cooking classes in the technical colleges, similar to that conducted in metalworking classrooms, where all imperial measuring devices were removed and replaced by metric devices with no special instruction in the use of the metric devices. In contrast with the results of the experiments in metal and woodworking classes, the cooking classes had a much higher rate of failure as compared with traditional classes. Some teachers converted the measurements themselves into exact equivalents and students didn't have the appropriate equipment for handling the resultant strange combinations of quantities. When teachers had their students convert the recipes, the students became bogged down in the mathematics involved.

Problems that loomed important to home economists in Great Britain were replacement costs of equipment and texts. Frequently, special funds were provided by local education agencies including a conversion allowance over a three-year period. Unfortunately, home economics educators were uaually ahead of the retail trade. The practical applications of metric usage in shopping were limited.

Communication and Coordination

If we follow the path of Great Britain, the lack of public involvement in conversion will be accompanied by general apprehension about conversion problems. British education faced occasional backlash reactions from parent groups. The need for extensive and early public education, special adult education and frequent parental conferences was stressed by respondents. It was not that adults persistently resisted conversion, but rather that they had not been informed and involved in the process. Principals in Australia said they were frequently asked to explain the rudiments of the metric system to the parents so that parents could assist their children.

A major problem foreseen in Great Britain was that the children would learn metric units before the general public would be using them. Thus, there would be an indefinite transition period where children would be faced with two sets of units. Primary schools adopted the policy that there would be an immediate emphasis on metric units, and although British units could be used for practical work, all calculations would use SI.

Australian respondents cited the same problems of lagging conversion in commerce and industry, and especially in the home, as compared with the schools. The concern is typified by the survey response: "Students will be doing nothing but metric units in school for years while still having to cope with non-metric units out of school."

The Tertiary Education (University) and Tertiary Education (Non-University) Sector Committees in Australia were presented particular problems because of the virtual autonomy of institutions and, at the university level, the autonomy of the various departments and individuals. The lack of communication and coordination in these areas created problems. In the case of universities, these problems have been significant, despite the fact that the Board and the committees provided considerable amounts of information to all tertiary education institutions and were ready to assist these institutions whenever they requested.

An example of the coordination efforts of Australia which have resulted in general consensus is indicated by the decision process concerned with changing primary schools to metric teaching. This was seen by the Primary Education Sector Committee as its first task. The possible schedule and the problems were first discussed among committee members and then between committee members and their state governments and other groups. By the time the Sector Committee was ready to make a recommendation, that recommendation had in effect been approved by many levels of people outside of the committee. The committee's recommendation was next considered by the Advisory Committee, taking into account the coordination with other sector decisions. The Advisory Committee's decision was then recommended to the Metric Conversion Board who considered the recommendation in the context of all of the Advisory Committees.

Once the Board recommended the policy to the appropriate federal minister, he would often consult with state ministers, who in turn would consult with their departments whose members on the Board had been involved in making the initial policy recommendation. In this way, everyone involved came to agreement with the recommended policy and it was officially announced in whatever was deemed the appropriate way. After this the various states adopted the recommended policy as their own policy and planned for its implementation. Many of the problems and procedures for implementation had already been thrashed out in the process of coming up with the recommended policy.

It is considered that the relatively smooth Australian experience with conversion has been due in large part to this process of working out of a policy by those who will have the responsibility for implementing it.

A special problem in the field of technical education was that conversion in this sector had to be coordinated with that in industry. Skilled workers and technicians had to use imperial units until industry itself converted.

Special attention was given by the South African government to the problems of consumers during the changeover. In some other countries, during the process of metric changeover, the unwary consumer was victimized with increases in prices, due to his or her unfamiliarity with the new units of measurement. This was reputed to be largely avoided in South Africa as a result of the minimum time span devoted to dual use of units.

In Canada, the need for extensive publication is emphasized by Allen (1973) who notes that the Metric Task Force in Ontario has already identified 13 different symbols for gram found on packages in Toronto supermarkets. Allen cites three other areas of concern based on his extensive contacts with Canadians in schools, service clubs and workshops. First, that the elderly will fear the change because it appears "hard;" that the housewife will assume she is being cheated and that metrication will be used as an excuse for raising prices; and finally, that parents, having only recently survived the new math, will fear a new "generation gap" where they will be less than sure of what is being taught their children. According to Allen, sufficient literature should be available to enable any parent to learn the new system right along with their children.

In all overseas countries, professional journals which helped keep staff informed on metric conversion ideas have been particularly helpful to teachers. The need for early training and familiarization by school staff and for keeping the awareness of the importance of metrication before the parents and public was repeatedly emphasized. The areas of publicity, committee and association pressure, and early planning for conferences were also stressed. The importance of early educational planning on the impacts of metrication and required changes in course areas was emphasized again and again.

Lack of Firm Direction

In Great Britain the long transition period and the lack of firm schedules or pressure by government agencies presented problems to all sectors. Examining boards, for example, felt they had to use great leniency on incorrect usage at first. The unevenness of conversion progress throughout Great Britain made it necessary for exam papers employing both Imperial and metric units to be retained longer than the examining boards would otherwise have preferred.

A lack of close policy agreement between the schools, exam boards and other agencies created added problems. For example, the British Ordinance Survey and the schools had difficulty reaching a consensus regarding metrication of geography maps.

The British government's hesitation in fixing firm schedules was almost universally cited as a major problem--other commonwealth countries publicized it, as an example of what not to do.

This problem area is by no means unique to Great Britain. Unfortunately some policy changes must be expected during a period when countries are still attempting to reach consensus on international standards. One example is the case of the decimal comma. During the early stage of conversion in Australia the period was advocated as the decimal marker. Late in 1973, members of the Australian Technical Education Sector Committee recommended to their departments that the comma be adopted as the preferred decimal symbol in cases where no ambiguity would arise. This recommendation was based on the recognition of the international recommendations with respect to the comma as the decimal symbol and the realization that the move to the decimal symbol is inevitable.

In a joint meeting of the Primary and Secondary Education Sector Committees, the implications of the decimal comma were discussed. The Committees concluded that although the problem seemed comparatively small in the primary sector, it could assume major proportions in the secondary sector. Variations in textbooks, their longevity, and the means of separating coordinates and items in sets were among the considerations advanced "to make haste slowly" in respect to the introduction of the decimal comma in secondary schools. It was agreed that members of the Primary Education Sector Committee would advise the Secretariat by mid-March 1974 as to the earliest and latest practical dates for introduction of the decimal comma into primary schools. The Secondary Education Sector Committee plans to meet toward the end of March to determine a program for introduction into secondary schools (MCB Newsletter, November 1973).

Special Problems in the Instruction and Use of the Metric System

De-emphasis of fractions. A persisting problem in metric education is when, in what form, and how much time will be devoted to arithmetic instruction in fractions. This is a crucial question to math teachers from the standpoint of curriculum design and bears heavily upon the question of how much time can be saved in the classroom if metric conversion is accomplished. Although claims of saving up to 25 percent of the time spent in arithmetic have been frequently voiced (U. S. Department of Commerce, 1971c), our survey did not reveal any empirical evidence confirming or refuting this claim.

In Great Britain, respondents reported that metrication has reduced the need to use common fractions for measurement, and "taken away the opportunity to learn the addition and multiplication of fractions in practical measures. The lessening of practice on fractions has allowed more time to the idea of rationals, of equivalence classes of fractions, and the fractional forms in algebraic expressions." Along this line Shaw (1971, p. 24) comments:

> When continental teachers have visited schools in this country they have frequently commented on the very considerable amount of time devoted to the fraction and the skills associated with it. In many cases this has been vastly greater than was customary in their own country and it is therefore evident that fractions receive much less stress where a tens-based system of measuring units is used. Looking ahead, one wonders to what extent our preoccupation with fractions will be affected by the adoption of metric units. One senses the danger of traditional attitudes being maintained and it is therefore most welcome to see the following affirmation in the Mathematical Association's recent booklet 'Introduction of SI Units in Schools'.
>
> '. . . the formal techniques for multiplication and division of fractions no longer have a place in primary schools. If they are needed in the secondary school, they will be learned there, when children are old enough to deal more easily with numbers in the abstract.'

The Australian Metrication Board recognized that a problem arises out of the great frequency with which decimal fraction forms will be used in the future.

> Thus, one will write 2.5 kg, 0.605 ha, 0.25 m. The use of the common vulgar fraction forms for one-quarter, one-half, three-quarters, etc., with these metric measures should be discouraged. Furthermore, children and citizens, in general, need to realize (with little or no thought) that 500 metres equals .5 km, 1.27 tonnes equals 1,270 kg, etc. . . . These matters of experience, then, lead to the unresolved problem . . . to what extent should the vulgar form of fractions be deemphasized and the decimal form more emphasized? A further problem remaining for discussion and solution concerns the question of whether fractions should be first taught in the decimal form (Glastonbury, 1972, p. 18).

Error and precision. The likelihood of error is not restricted to training materials, as mentioned previously, but will certainly be a problem in all communication during the transition period. For example, a company in South Africa received an invitation from a government department to bid on the supply of survey equipment. The specification for the levelling instruments required stated "the primary method of levelling the instruments should be by means of 0.9 m screws." It took awhile for the recipient to realize that what was required were levels with three foot-screws (Metric Information Service, April 1972). Already a U. S. metric magazine has highlighted its first issue with the selection of Miss Metric America with the reported laudable dimensions of 92-64-92, and a height of 18 cm (Metric News, September/October 1973).

The striving for unnecessary precision is also an error to which we can easily fall prey. How often have students been appalled by the fact that one pound equals 453.592 grams or that one mile equals 1.609 kilometres? A more interesting statistic, perhaps, is the quoting of bathing beauty dimensions as 914-610-914 millimetres, rather than 91-61-91 centimetres. Recently, for example, a Sydney, Australia newspaper quoted the police description of a man as "175.2 cm to 180.3 cm tall." The comment was then made that "a thick pencil stroke can measure point one of a centimetre, thus using anything but whole centimetres to measure a person's height is much the same as describing him as between 25 years, two months and three days, and 30 years, four months and one day old (MCB Newsletter, August 1973, p.6).

The New Zealand Metric Advisory Board advises that the ability of decimals to indicate greater accuracy simply by adding another figure may trap the unwary, both in writing down of measurements and in giving results of calculations. They suggest, for example, ". . . that when building a new fence, you measure the distance with a steel tape, to the nearest centimetre, and find the length to be 21.44 m. Six intermediate posts are to be used, so that their distance apart will be found by dividing the above figure by 7. This comes out to 3.062 857 etc. m. But because the original measurement was made only to the nearest centimetre, the answer cannot be more precise than this, and should be given as 3.06 m. Any further figures merely give a false impression of accuracy and serve no purpose. Indeed all they can do is to cause readers to think that they are expected to space the posts accurately to the nearest tenth of a millimetre, or something equally ridiculous. While this is fairly obvious when it is pointed out, it is often overlooked, even by some who should know better, like scientists and engineers (Metric Advisory Board, 1973)."

Mass vs. weight. According to Glastonbury (1972), for the first time teachers will have units of mass (quantity of matter) and weight (gravitational force) whose names are distinctive. It is felt that this should make it easier for many students to distinguish between these concepts, with the consequence that teachers in primary schools will now have an opportunity to point up the fact that when the housewife buys meat or vegetables, or butter or flour, she is concerned primarily with how much material she buys. In the past, the emphasis seems to have been that she was most immediately concerned with weight, the size of the pull exerted by the earth on her purchase; and it was not until secondary school that the student heard and saw the word "Newton," the name of the unit of force.

However, distinguishing between the two concepts has been a matter of concern to teachers in Great Britain, particularly primary teachers, as mentioned previously in this report.

Breadth of Impact

There is a danger in assuming that only mathematics and science will be significantly affected by metric conversion. On the contrary, the teaching in all subject areas is affected, especially at the secondary level. As suggested earlier, those subject areas which can expect a multiplicity of problems are social science, home economics, and industrial arts. According to the Research and Curriculum Branch of the Department of Education in Queensland, Australia (1973), metrication will simplify many of the calculations involved in map work and will facilitate the use of comparative statistics, especially in economic geography and in economics. Although exports and imports will be more readily comparable to those of other metric countries, there is a complication in the study of long-term trends in Australia since much of the existing data is in imperial units. One solution is to convert past imperial statistics into metric equivalents. Metric equivalents of familiar measurements may appear strange in the initial stages of conversion, however. In social science, probably more than any other study area, metric conversion involves students with a wide range of new units and requires converting existing statistics to metric equivalents and updating reference materials. This will certainly be a point of concern to social science teachers in the U. S.

How Respondents Would Change their Country's Approach to Metrication

Respondents were asked: if they had the opportunity to begin preparation for metric education all over again, what specific things would they recommend be done differently--by their own agency and by other agencies.

In Great Britain two of the most frequent suggestions were: adherence to a strict schedule and a more active role by the government and the Metrication Board in implementing and enforcing changeover.

The prevailing view was that, typically, schedules were announced--but they were allowed to slip drastically. This penalized the very groups that had worked hardest to meet the original schedule. The Metrication Board and the Government had set forth goals and exhorted, but had never put a strong commitment or any "punch" behind the program.

A third frequently cited change in approach was to emphasize public awareness and involvement in metrication early and throughout conversion. The lack of publicizing the benefits of metrication to the citizen, of assuaging fears of the consumer, and the lack of early planning for diffusion of information to all segments of the public appear to be major mistakes as seen by respondents in Great Britain.

Britain's policy was to encourage each type of industry to schedule conversion at its own rate. The lack of national coordination in timing important steps, steps that have radiating consequences for other portions of society, was referred to by respondents as pointing up the need for a difference in approach: increased coordination and communication.

The educational exam boards suggested: (1) generally, a stricter changeover schedule and (2) specifically, within their own role, more attention to the analysis of initial specimen exam papers to identify discrepancies between practice and desired standards. In this way, useful feedback to local educational authorities could take place.

For education, more advanced and extensive planning was recommended. British respondents felt that educational planning in Great Britain failed to trace clearly the potential impact of conversion in all subject areas.

Areas outside of math and science need this advance help. Careful planning to take into account costs involved, effort required and time was stressed by the British who now, with hindsight, would establish in the very early phases of conversion evaluation and safeguard reviews for materials and equipment.

Lack of early educational planning often led to unexpected needs for money. The failure to provide for inspection committees to investigate equipment and training materials has been mentioned previously.

Among the suggestions provided from our Australian respondents were the following:

- There should be no important change of policy during the implementation phase of the conversion program. One example of such a policy change was the MCB's position on the use of the period as a decimal marker. After two years, the policy was changed to advocate the decimal comma, which has led to confusion among teachers. Another area where a definitive ruling should have been issued by some governmental agency at an early time was the convention on writing non-metric quantities such as money. There has been some doubt in Australia as to whether a quantity of money should be written with a comma separating each set of three digits or with merely a space separating the digits, or whether all the digits should be run together in order to avoid unauthorized changes.
- Adequate coordination among all concerned should be obtained and the time required for carrying out particular tasks should not be underestimated.
- A more positive approach to parental education in metrication through the schools should be planned. "Here was an example of a great use that could have been made by school authorities in community involvement relative to metric education."
- Meetings between representatives of school systems, the National Standards Association, and school equipment manufacturers should have been conducted well ahead of the time for implementing metric conversion in order to draw up specifications for a comprehensive range of school aids and equipment.

- Ample funds specifically earmarked for metric courses should be available.

- Materials going to schools for use by teachers should be provided in ample supply--each teacher to have a personal copy for individual use.

- Syllabus amendments should be published before changing to a new system.

- Special teacher training for adult education in metric conversion is necessary.

- It was difficult to get in touch with the blind, who would not get in touch with the MCB. "The deaf can read material published, but the blind cannot and are hard to reach."

Respondents in South Africa showed little inclination to do things differently--except to have converted 50 years ago. Most reported they felt things had gone as well as one could reasonably hope.

Suggestions from New Zealand are only beginning to arrive at the time of this report. Canada was considered far too early in its conversion to fairly respond to this issue.

The overall lessons of Great Britain's metric experience, shared and used as a policy guide by others, were evident in the conclusions of the Commonwealth Conference on Metrication held in London, April 1973. Twenty countries and East African communities were represented. The major conclusions from the conference were:

1. Consumer confidence is immensely important. Consumers need to be reassured and have their interests protected. The packing and marking of consumer goods is highly important.

2. An effective information policy is indispensable; it needs to be carefully directed to the right audience at the right time through the right media. Awareness in advance, and knowledge and understanding through involvement are crucial.

3. Important roles in the information dissemination function are to be played by all government departments, industry, and particularly teachers who have an indispensable role.

4. The effectiveness of the information program depends in part on the development of timetables for the sectors of interest and by evidence that the change is really happening and that the government is supporting the change.

5. Metrication calls for a large amount of legislative change involving central and local government. The need for this is not always appreciated and delay is costly. In addition to amending existing legislation, it is important that all new legislation be in metric terms (Commonwealth Information, 1973).

The conclusions of this conference are consistently supported by our findings.

IMPLICATIONS AND RECOMMENDATIONS FOR U. S. EDUCATION

While this report reflects the experiences and recommendations of representatives of over 70 key agencies and associations in countries currently undergoing metric conversion, the reader should be reminded of the major limitations of this exploratory study. First, the process of metrication is still underway in the countries surveyed and the ultimate effects of various strategies are yet to be determined.

Second, the study was deliberately restricted to upper echelon organizations in keeping with budget constraints. Emphasis was primarily upon planning and policy-making organizations, with individual schools and teachers remaining for a later, in-depth study.

A third major restriction to the current study was the need to rely almost exclusively upon mail survey and analysis of publications. Very little time and funds were available for personal interview and observation in this first effort. With these constraints in mind, the following study conclusions and recommendations are presented.

For Public Policy Makers:

- Need for broad-scale involvement of all major elements in society in the early planning for metric conversion.

It is apparent from a comparison of experiences in the five countries studied that to limit conversion planning to major industrial representatives is indeed a mistake. Professional associations, labor organizations, small business and the general public should be involved from the very start of conversion. Probably the greatest mistake is to overlook representation from the consumers and the general public when creating metric planning boards and committees. Such representation early in planning would ensure that planning for achieving benefits related to metric conversion, e.g., rationalization and standardization of sizes, would reflect consumer as well as producer interests. The planning for safeguards against unwarranted price increases, the identification of justifiable costs in time and materials, and the realistic estimation of perceived benefits deserve adequate study by a broadly based group, not merely industrial and government representatives.

A thorough study of the costs versus benefits of metrication to the general public has yet to be made. There is certainly no better vehicle for such a study than the five English-speaking countries now undergoing conversion. An in-depth study would, in addition, identify the types of incentives most effective in promoting conversion.

- Need for committed government policy and firm schedules.

Whole-hearted bipartisan commitment by the federal government, and the involvement of the states in establishing metric policy so that they are partners in the commitment, appears crucial. Conversion to metric is long, involved and disrupting at best. A "soft" policy accompanied by prolonged periods of dual measurement and retreating schedules appears to heighten confusion and human misery as well as being ineffective. Timetables must be carefully developed. Metrication entails intricate intersects across the range of economic and social activities of the country, and requires a finely orchestrated schedule. Once established, these timetables must be closely adhered to.

A useful precursor to establishing a detailed policy commitment would be to examine the options and issues still existent among current applications of the metric system. For example, there remain a number of unresolved issues with respect to standards, appropriate symbols and even to appropriate units of measurement, e.g., pascals versus bars in meteorology. Of course, by waiting long enough, most of these may be resolved before U. S. entry into the metric community. And, by waiting passively we need not be tarnished by the conflict or have input into the decisions.

A close scrutiny of the timetables planned and the timetables followed by the other countries, together with an assessment of schedule-related problems and their solutions should offer a valuable input to our own planning.

- Need for continuing communication and coordination as conversion progresses.

The pervasiveness and interdependency of metrication places a premium on careful coordination among all sectors of society. For example, conversion progress or lack of progress within separate industries, retail trade, professional practices, training institutions, employment requirements, and packaging regulations can reverberate throughout the other areas. The difficulties of obtaining uniform state policies and regulations with respect to other important issues could appear minimal compared to a Babel of 50 different approaches and schedules for metrication.

Communication about the metric system and current plans to all organized groups and to all citizens may require a sizeable investment. Although overseas evidence points to delaying actual training until metric knowledge and skills are to be applied, a well-in-advance communication of the need, the relative advantages, and the consequences of metrication requires early and continued information and feedback.

The example of Australia in establishing some initial, highly visible common frame of reference in metric, e.g.,sports and weather reports, may be useful. However, before making any no-return decisions which call for substantial investment, more information gathering and a finer level of detailed observation should be undertaken.

Plans for communication and coordination would be enhanced by a comprehensive identification of resistance sources, how these arise, what needs and values are apparently placed in jeopardy by the change, and of what incentives were used to work through or prevent unnecessary resistance to conversion. We believe that the present project has made a useful start at this identification.

The above recommendations, while oriented toward policy makers in general, can also be interpreted from the standpoint of the education community specifically. The issues of broad-scale involvement, firm schedules, and continuing communication are all matters of concern to educators in the converting countries.

The following implications and recommendations are specifically directed to educators and to policy makers and research personnel in the field of education.

- The early, intense demand for metric materials results in a flood of inaccurate and inadequate materials.

Materials produced under pressure to meet the new demand are likely to contain errors and frequently are unsuitable for classroom use or learning objectives. The producers of materials need to be involved in early planning sessions with educators. Standards established in the first stages of conversion can reduce materials problems. A common omission across the overseas countries was the failure to provide for a materials evaluation. Such a service, for example,conducted on a national basis and broadly communicated to schools, could provide a useful guide to metric programs and a sobering influence on materials production.

Overseas educators were, for the early stages, often uninformed about available metric materials. They were inclined to grasp at the first apparently relevant object. As simple a contribution as a noncommercial, comprehensive catalogue of existing materials would do much to allay early concern and hasty decisions.

As staff become experienced in metric teaching, they discover numerous techniques of producing inexpensive, teacher-made and student-made materials. Overseas, this was slowly learned by trial and error. U. S. education would capitalize on this achievement and make substantial time and dollar savings, by conducting a specific review of these techniques and widely disseminating the results to U. S. teachers.

- The impact of metric education extends well beyond science and mathematics.

The areas less obviously impacted by metric often receive little attention in early planning. However, the overall impact on, for example, vocational education and home economics is substantial in terms of instructional strategies and materials, and often becomes an acute problem with respect to equipment costs. The social studies are pervasively influenced. Geography in particular is faced with difficult problems in changing map dimensions and quantitative reporting. As conversion proceeds, even history texts will require numerous changes.

The impact on examinations, together with the problems of coordinating curriculum and examination, was underscored in Great Britain. A similar problem could face U. S. education in college entrance and technical achievement exams. The issues in modifying standardized tests and Intelligence tests, which contain a number of items based on the "English" system, has not yet surfaced overseas, but can be anticipated.

- Effective teacher training programs include more than knowledge of the metric system and specific units.

All teachers are likely to need some training or updating. Many who have specific knowledge of metric often have misconceptions and employ outdated units and symbols which are not contained in SI. Beyond SI proper, an important training goal is understanding the need for conversion and its impact on the nation as well as on the teacher's particular subject area. The importance of this metric awareness to staff and students was repeatedly underscored.

Most teachers reportedly had fears and doubts about learning metric and required reassurance and support. Detailed identification of these blocks to teacher training, and a description of strategies to reduce them would be a useful input to planning U. S. training programs.

The relative effectiveness of teacher centers in Great Britain, of traveling resource teachers in Australia, and of the active "hands on" workshops and special teacher training kits were consistently reported by our sources. Such reports merit more scrutiny and careful, detailed investigations.

Teachers may find new opportunities for parent and adult education with respect to conversion. The overseas experience was that many teachers felt unable to use this opportunity without specific training or orientation to working with adult groups.

- The choice of specific strategies for teaching the metric system can facilitate or impede "thinking metric."

This study was not designed to identify specific teaching strategies most successful in teaching SI. Nevertheless, some major issues repeatedly surfaced during our survey. One of the common, reported mistakes in teaching SI, for example, is the reliance upon conversion tables and drills. Experience in the target countries clearly pointed to faults in such strategy and the associated problem of extended use of dual labels and markings. Our survey respondents and numerous overseas publications stress the importance of immersion in SI and the estimation and direct measurement of common objects with metric measures. The early conversion of school equipment can often be accomplished by students as part of their metric education.

One technique employed with both children and adults is the demonstration that the concept of measurement is independent of the specific measuring units used. Emphasis upon measurement activities was similarly stressed for both groups. In the adult area specifically, there were numerous cautions to gear the extent of training only to that actually needed and to guard against training too far ahead of actual application. Personal contacts were reported to be most important in motivating and educating special groups. For example, the day-to-day contacts of agricultural extension agents can play a major role in farmers' "going metric."

Evidence for the effectiveness of such strategies, and the relative ineffectiveness of others, rests upon the judgment of experienced participants in metric education. It is plausible and based on consensus. However, it is not the kind of experimentally validated evidence that fulfills the canons of behavioral science. No acceptable research evidence concerning teaching strategy, other than that noted in the introduction of this report, was located by our staff. The relative merits of these, and other approaches await carefully designed and controlled studies.

- Claims of major savings in instructional time through use of SI are many, but research evidence is lacking.

Throughout the contries studied claims abound for the savings of time and effort if the metric system is adopted. These claims, ranging up to 25% of the time spent in arithmetic and as much as 500 million dollars in time per year (U. S. Department of Commerce, 1971c), are based largely on the drastic reduction of time spent upon fractions. While they are often cited as fact, no experimental evidence could be found in their support. The most recent claim came in November 1973 from the Chairman of the British Metrication Board who stated that "It has been worked out that under the new system a maths book would be 80 pages, whereas before metrication the equivalent maths book would be 180 pages (Luton Evening Post, 10 November 1973)." If such claims are in fact supported, the obvious impact upon education is sizeable. On the other hand, if they are refuted (or drastically diminished) then we should not continue the fraud as we attempt to convince American educators to "go metric." Testing of this hypothesis of metric impact deserves high priority.

- Metrication provides an expanded role for schools in adult education.

During the course of metric conversion in the countries studied, the schools have been presented with the opportunity to expand their role in the community and assume greater responsibilities for adult education. Metric conversion in the U. S. will no doubt offer similar challenges. Schools will very likely be called upon to provide additional courses for adults--both general education teachers and specific job training teachers of many disciplines, e.g.,math, science, trade and industrial education, home economics, can all contribute. Parent-teacher association meetings and other school functions can be instrumental in setting the neighborhood tone toward SI. Even more important but more likely to be overlooked is the role that students can and will play in educating their parents. The attitudes and practices of teachers, as reflected through their students, will do much to convince parents to support or resist metric conversion.

In summary, this exploratory study has attempted to demonstrate that we can learn from other countries' metric experiences. The fact that a country can profit significantly from another country's experiences is amply demonstrated by the success that Australia's metric conversion program has demonstrated. Without in any way detracting from the creativity and problem solving ability of the Australians, it is a testament to their acumen that they were willing to observe the British experience and take steps to avoid reinventing the wheel of misfortune as they designed their own program. The fact that the U. S. lags behind every other major country in conversion to the metric system presents us with a truly unique opportunity to learn from these other countries. This exploratory study is presented as a first step.

REFERENCES

Allen, H. D. Canada measures up, A guide to metric practices. Agincourt, Ontario: General Learning Press, 1973.

American National Metric Council. Boire reports metric conversion well underway in Canada. Metric Reporter, November 1973, 1(3), p. 8.

American Psychological Association, Council of Editors. Note to APA journal authors. American Psychologist, 1969, 24, 616.

American Psychological Association, Council of Editors. Journal policy on units of measurement. American Psychologist, 1971, 26, 1099.

Bank of Montreal (The First Canadian Bank). Canada prepares for metric conversion. Business Review, January 1974, p. 3.

Biggs, E. The impact of metrication on the education service. Advancement of Science, March 1970, 26, 234-240.

Boire, P. C. Progress toward metric conversion in Canada. In A. B. Chalupsky (Chm.), Conversion to the international metric system: Impact on the U. S. and Canadian consumer. Symposium presented at the annual convention of the American Psychological Association in Montreal, August 28, 1973.

Committee in Weights and Measures Legislation. Hodgson Committee Report. Cmd. 8219, HMSO, 1951.

Commonwealth Bureau of Meteorology. Temperature and pressure go metric. Canberra, Australia: Author, 1972.

Commonwealth Information. Press communique on Commonwealth Conference on Metrication, 24-27 April, 1973. London: Commonwealth Secretariat. (Mimeo)

Department of Consumer and Corporate Affairs. Metrication, a guide for consumers (Second ed.). Consumer Research Report No. 2. Ottawa, Canada: Information Canada, 1973(a).

Department of Consumer and Corporate Affairs. Metrication, a guide for producers of packaged goods... (Second ed.). Consumer Research Report No. 4. Ottawa, Canada: Information Canada, 1973(b).

Department of Education (Administration of South West Africa). Circular E. 54/69 (To: European Government Schools, Professional Staff and Private Schools). Windhoek, S.W.A.: Office of the Director of Education, 1969. (Mimeo)

Department of Information. The metric system - Plans for its adoption in South Africa. Background Series No. 53. Pretoria, South Africa: Department of Information, Data Division, October 1969. (Mimeo)

Department of Trade and Industry. *Metrication*. London: Her Majesty's Stationery Office, February 1972.

Donovan, F. *Prepare now for a metric future*. New York: Weybright & Talley, 1970.

Ede, A. J. *Advantages of the metric system*. London: Her Majesty's Stationery Office, 1972. 92 pp.

Fineblum, C. M. *Key issues concerning the adoption of the metric system and implications for the education of exceptional children*. Arlington, Va.: Information Center on Exceptional Children, 1970.

Glastonbury, J. Metric conversion and education. *Education News*, December, 1972, *13*(12), 16-18.

Government of Canada. White Paper on metric conversion in Canada. Department of Industry, Trade and Commerce, January 1970.

Hansard (Commons). Vol. 713, col. 32-33(W), 1965.

Hansard (Commons). Vol. 769, col. 1167-1171, 1968.

Johnson, J. T. Three studies on the effect of compulsory metric usage. *Journal of Educational Research*, 1944, *37*, 587-592.

Kent County Council. *Metrication III, SI in handicraft and technical drawing*. Springfield Maidstone, England: Kent Education Committee, June 1973.

Luton Evening Post. Metric's a marvel. Luton, England: *Luton Evening Post*, 10 November 1973.

Luton News. Reward for the metric champs. Luton, England: *Luton News*, 22 November 1973.

Mayer, J. Why metric move is opposed for business and nation. *Forbes*, 1924, *13*, 631-632, 649-651.

MCB Newsletter. 'Nauseating non-art' or the 'bloke for the job'? St. Leonards, New South Wales: Australian Metric Conversion Board, February 1973, vol. 2, No. 4, p. 1.

MCB Newsletter. Metric quotes. St. Leonards, New South Wales: Australian Metric Conversion Board, May 1973, vol. 2, No. 7, p. 4.

MCB Newsletter. Effective and inexpensive method of recalibrating feed screw indicators. St. Leonards, New South Wales: Australian Metric Conversion Board, August 1973, vol. 2, No. 10, p. 3.

MCB Newsletter. Rural seminars take place in Tasmania. St. Leonards, New South Wales: Australian Metric Conversion Board, October 1973, vol. 2, No. 12, p. 3.

MCB Newsletter. Reporting from the Committees. St. Leonards, New South Wales: Australian Metric Conversion Board, November 1973, vol. 2, No. 13, p. 3.

Metric Advisory Board. Covering the work of the Board from its first meeting in November 1969, until 31 December 1972. Wellington, New Zealand: Metric Advisory Board, no date. (Mimeo)

Metric Advisory Board. *Metric memo no. 5, Working in decimals*. Wellington: New Zealand Consolidated Press Ltd., 1973. (Pamphlet)

Metric Advisory Board. *Newsletter No. 13*. Wellington, New Zealand: Metric Advisory Board, August 1973. (Mimeo)

Metric Association. Canadian developments. *Metric Association Newsletter*, November 1973, vol. 8, No. 4, p. 4.

Metric Commission. Brochure. Ottawa, Canada: Metric Commission, 1973.

Metric Conversion Board. Metric conversion & you. Melbourne, Australia: Metric Conversion Board, no date. (Booklet)

Metric Conversion Board. *Industrial training for metric conversion in Australia*. St. Leonards, New South Wales: Metric Conversion Board, 1971. (a)

Metric Conversion Board. *Metric conversion for Australia*. Canberra, Australia: Australian Government Publishing Service, 1971. (b)

Metric Conversion Board. *First annual report for year 1970-71*. Canberra, Australia: Commonwealth Government Printing Office, 1972.

Metric Conversion Board. *Metric practice*. Canberra, Australia: Australian Government Publishing Service, 1973. (a)

Metric Conversion Board. *Second annual report for year 1971-72*. Canberra, Australia: Commonwealth Government Printing Office, 1973. (b)

Metric Information Service. London: Rovipress Ltd. April 1972, Issue 63, Section G.2.

Metric Information Service. London: Rovipress Ltd. September 1973, Issue 94, Section G.4.

Metric Information Service. London: Rovipress Ltd. December 1973, Issue 100, Section 0.1.

Metric News. "Miss Metric America 1974." Roscoe, Illinois: Swani Publishing Company, September/October 1973, vol. 1, No. 1, p. 20.

Metric News. Metric curriculum proposed for South Carolina schools. Roscoe, Illinois: Swani Publishing Company, January/February 1973, vol. 1, No. 3, p. 13.

Metrication Board. Going metric: The first 5 years 1965-69. London: Her Majesty's Stationery Office, 1970.

Metrication Board. Going metric-Progress in 1970. London: Her Majesty's Stationery Office, 1971.

Metrication Board. Going metric: Looking ahead. London: Her Majesty's Stationery Office, 1972.

Metrication Board. Going metric: Progress in 1972. London: Her Majesty's Stationery Office, 1973.

Murphy, M. O., & Polzin, M. A. A review of research studies on the teaching of the metric system. The Journal of Educational Research, 1969, 62, 6.

National Union of Teachers. Metrication: No turning back. London: NUT, Hamilton House, Mabledon Place, 1971.

Newsweek. Meter readers. May 7, 1973, p. 65.

Nova critters from centimetre cubes. Nova Scotia Teachers College, 1972-73. (Mimeo)

Petroleum Industry Training Board. Metrication, Training guidelines for the UK petroleum industry. Wembley, Middlesex: Author, May 1972.

Research and Curriculum Branch, Department of Education, Queensland. Let's go metric: Handbook. Queensland, Australia: Author, 1972.

Research and Curriculum Branch, Department of Education, Queensland. Introducing metric units into primary schools, Curriculum Paper, February 1973, No. 1.

Research and Curriculum Branch, Department of Education, Queensland. Guidelines: Metrication and the secondary teacher. May 1973.

Schools Council. Change for a pound: A teaching guide for the introduction of decimal currency and the adoption of metric measures. 2nd ed. London: Schools Council Publications, 1970. (a)

Schools Council. Measure for measure: a guide to metrication for workshop crafts and technical studies. London: Schools Council Publications, 1970. (b)

Schools Council. Metres, litres & grams. London: Schools Council Publications, 1971.

Shaw, R. W. Going metric--going decimal. Mathematics in School, 1(1), November 1971, 23-24.

South African Bureau of Standards. Metrication in local government. Pretoria: Author, July 1970.

South African Bureau of Standards. Metric News. April 1972. (Supplement to SABS bulletin)

South African Bureau of Standards. Metric News. M4 September 1972, No. 9.

South African Bureau of Standards. Metric News. M5 September 1973, No. 9.

The Bookseller. The education world is forcing metrication on us, MPs protest. March 27, 1971, p. 1662.

United States Department of Commerce. *A history of the metric system controversy in the United States*. National Bureau of Standards Special Publication 345-10. Washington, D. C.: U. S. Government Printing Office, August 1971. (a)

United States Department of Commerce. *A metric America: A decision whose time has come*. National Bureau of Standards Special Publication 345. Washington, D. C.: U. S. Government Printing Office, July 1971. (b)

United States Department of Commerce. *U. S. metric study interim report, Education*. National Bureau of Standards Special Publication 345-6. Washington, D. C.: U. S. Government Printing Office, July 1971. (c)

United States Department of Commerce. *Testimony of nationally representative groups*. National Bureau of Standards Special Publication 345-12. Washington, D. C. : U. S. Government Printing Office, July 1971. (d)

United States Department of Commerce. *The consumer*. National Bureau of Standards Special Publication 345-7. Washington, D. C. : U. S. Government Printing Office, July 1971. (e)

Washington Post. Md. schools start converting to metric system in 1974. 30 August 1973.

Williams, E. Metrication in Britain. *The Arithmetic Teacher*, April 1973, 261-264.

Yorke, G. C. Three studies on the effect of compulsory metric usage. *Journal of Educational Research*, 1944, *37*, 343-351.

APPENDIX A

Système International d'Unites (SI)

Many variations of the original metric system have developed since the end of the 18th Century despite its logic and inherent simplicity. In truth the term "metric system" had come to imply merely a decimal system of measurement connected with the metre. In 1960, the General Conference for Weights and Measures adopted the Système International d'Unites (SI). In SI, the units are defined for reproducibility in any well-equipped laboratory except for the kilogram, the prototype of which is kept at Sevres, France at the International Bureau for Weights and Measures. The SI is a coherent system, i.e., the product or quotient of any two unit quantities produces the unit of the resultant quantity. The SI has been adopted in England, New Zealand, Australia, South Africa, Canada and other countries, including Germany and France which used the old metric systems. SI consists of seven base units:

Quantity	Name of Unit	Symbol
1. Length	Metre	m
2. Mass	Kilogram	kg
3. Time	Second	s
4. Electric Current	Ampere	A
5. Thermodynamic Temperature	Kelvin	K
6. Light Intensity	Candela	cd
7. Amount of Substance	Mole	mol

APPENDIX B

Organizations Represented by Survey Respondents

United Kingdom

Associated Examining Board, Aldershot, Hants

Joint Metrication Board of the Universities of Manchester, Liverpool, Leeds, Sheffield and Birmingham

Oxford Local Examinations Delegacy

Chemical and Allied Products Industry Training Board

Man-made Fibres Producing Industry Training Board

Paper and Paper Products Industry Training Board

Petroleum Industry Training Board

Printing and Publishing Industry Training Board

Schools Council for Curriculum and Examinations

National Council for Education Technology

British Institute of Management

Metropolitan Regional Examining Board for the Certificate of Secondary Education

Oxford and Cambridge School Examination Board

University of Cambridge, Local Examinations Syndicate

University of London, Entrance and School Examinations Board

Welsh Joint Education Committee

Carpet Industry Training Board

Construction Industry Training Board

Engineering Industry Training Board

Food, Drink and Tobacco Industry Training Board

Local Government Training Board

Road Transport Industry Training Board

Shipbuilding Industry Training Board

Department of Employment, Training Division

Fire Service Technical College

Association of Assistant Mistresses

Association of Headmasters

National Union of Teachers

Department of Education and Science

United Kingdom (Cont.)

- Institute and College of Craft Education
- National Institute of Adult Education
- Nuffield Foundation
- The Mathematical Association
- Yorkshire Regional Examinations Board
- Southern Regional Examinations Board
- United Kingdom Federation for Education in Home Economics

Australia

- Australian Geography Teachers Association
- Department of Education, Western Australia
- National Department of Education
- Wide Bay Education Region, Queensland
- Workers Educational Association of New South Wales
- Department of Education, New South Wales
- Adult Education Board, Tasmania
- Board of Adult Education
- Department of Education, Queensland, Research and Curriculum Branch
- Department of Education, Queensland
- Catholic Education Commission, Western Australia
- Australian Council for Educational Research
- Department of Education, New South Wales
- Department of Education, Darling Downs Region, Queensland
- Department of Science, A.C.T.

South Africa

- Department of Education, Orange Free State
- University of Durban - Westville
- Witwatersrand College for Advanced Technical Education, Johannesburg
- Department of Education, Cape of Good Hope
- University of Fort Hare, Alice, C. P.

South Africa (Cont.)

University of Pretoria

Potchefstroom University for Christian Higher Education

Cape College for Advanced Technical Education

Natal College for Advanced Technical Education

Natal Education Department

Education Department of South West Africa

University of the Witwatersrand

South African Association for Technical and Vocational Education, Transvaal

South African Bureau of Standards

New Zealand

Department of Education - School Publications Branch

Department of Education - Curriculum Development Unit

Central Institute of Technology

New Zealand Technical Correspondence Institute

Department of Scientific and Industrial Research

Post Office Headquarters - Personnel and Training Division